Curran

CTRANS
A MONTE CARLO PROGRAM FOR RADIATIVE
TRANSFER IN PLANE PARALLEL ATMOSPHERES
WITH IMBEDDED FINITE CLOUDS – –
DEVELOPMENT, TESTING AND
USER'S GUIDE

Prepared for
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

December 8, 1976

Applied Systems Department Report Number 006–76

EG&G

WASHINGTON ANALYTICAL SERVICES CENTER, INC.

WOLF RESEARCH AND DEVELOPMENT GROUP

CTRANS
A MONTE CARLO PROGRAM FOR RADIATIVE TRANSFER IN PLANE PARALLEL ATMOSPHERES WITH IMBEDDED FINITE CLOUDS -- DEVELOPMENT, TESTING AND USER'S GUIDE

Prepared for

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared by

Wolf Research and Development Group
EG&G/Washington Analytical Services Center, Inc.
6801 Kenilworth Avenue
Riverdale, Maryland 20840

December 8, 1976

Applied Systems Department Report Number 006-76

TABLE OF CONTENTS

SECTION 1.0
INTRODUCTION

This report describes the program called CTRANS which has been designed to perform radiative transfer computations in an atmosphere with horizontal inhomogeneities (clouds). Since the atmosphere-ground system was to be richly detailed, the Monte Carlo method was employed. This means that results are obtained through direct modeling of the physical process of radiative transport. The effects of atmospheric or ground albedo pattern detail are essentially built up from their inpact upon the transport of individual photons. CTRANS actually tracks the photons backwards through the atmosphere, initiating them at a receiver and following them backwards along their path to the sun as shown schematically in Figure 1.0.1. Backwards tracking has several advantages: the pattern of incident photons generated through backwards tracking automatically reflects the importance to the receiver of each region of the sky. Further, through backwards tracking, the impact of the finite field of view of the receiver and variations in its response over the field of view can be directly simulated. The backwards tracking method, additionally, is well suited for segregating results according to the character of the final scattering suffered prior to entering the receiver.

Section 2.0 describes the backwards tracking Monte Carlo method. In Section 3.0, the results of a range of test applications are reported which serve to illuminate the capabilities and limitations of the program. Section 4.0 contains brief descriptions of each routine comprising CTRANS. Since CTRANS is a highly generalized program with many operational modes and a variety of data structures, Section 5.0 outlines the input parameters. Finally, Section 6.0 contains a FORTRAN listing of CTRANS.

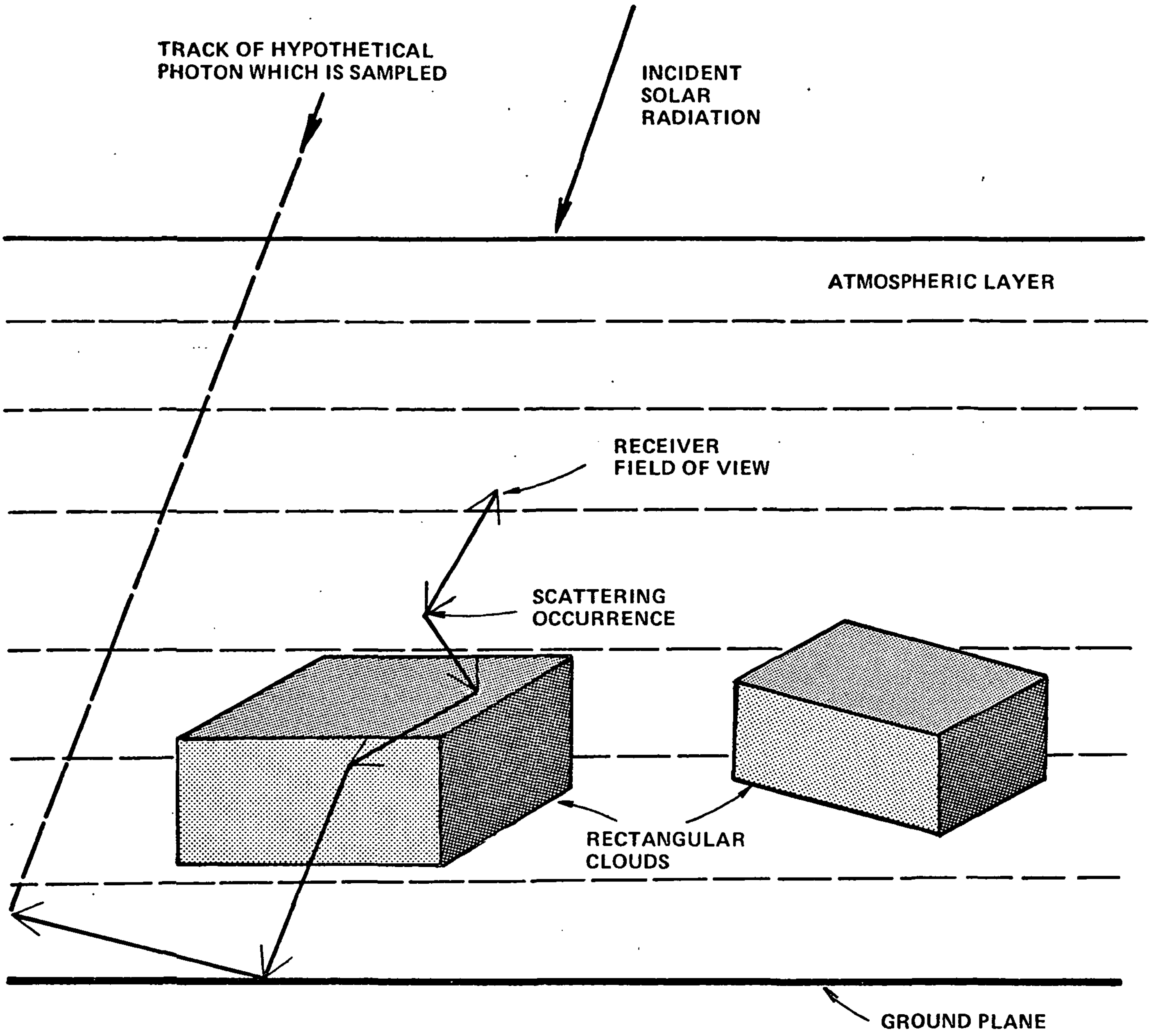


FIGURE 1.0.1. SCHEMATIC REPRESENTATION OF THE PROBLEM GEOMETRY AND THE BACKWARDS MONTE CARLO METHOD

SECTION 2.0
MONTE CARLO METHOD

CTRANS employs the Monte Carlo method to compute flux or intensity upon a receiver situated in or above a plane parallel atmosphere. Photons are tracked backwards through the atmosphere from the receiver along their path to the sun.

The particular advantage offered by the Monte Carlo method lies in the degree of complexity of the earth-atmospheric system which can be modeled.

The present code can handle a plane parallel atmosphere with up to 100 homogeneous layers. Each layer can be composed of up to five distinct scattering (or absorbing) species: molecular scatterers, monodisperse or polydisperse aerosols or hazes, ozone, etc. Further, there may be up to 10 finite rectangular solid clouds which are superimposed upon the layered atmosphere. Each cloud may be composed of any of the five allowed active atmospheric components with an independently specified density for each cloud. Thus, the atmosphere may be inhomogeneous both vertically and horizontally.

The treatment of ground reflection is also generalized. Reflectance at the ground may be either Lambertian or Fresnel in character. Fresnel regions are further characterized by a surface roughness specified by a probabilistic slope distribution (so chosen as to provide an approximate model of a sea surface with waves). The ground plane need not be uniform; rough Fresnel and Lambertian regions may be intermixed in a patchwork fashion as specified by a reflectance type map. Any Lambertian regions may be further broken down into patches having different Lambertian albedos. Results are computed for up to 50 different overlying maps of the Lambertian albedo, simultaneously. Aside from the gain in computational efficiency,

this is important because it provides a means for computing the relative effects of changing the ground albedo pattern with a precision which far surpasses the absolute precision of the Monte Carlo results for a single map.

2.1 PHOTON TRANSPORT AND SAMPLING

CTRANS tracks photons backwards initiating them at the receiver and following them through successive scatterings on their path through the atmosphere. Backwards tracking has been adopted for a number of reasons. It permits the efficient and direct simulation of receivers with finite fields of view and/or finite extent. A forward tracking scheme would require the distribution of initial photons over a wide area when horizontal inhomogeneities are present and this would introduce large variances in the results. By initiating photons at the receiver, this source of variance is largely avoided.

To understand backward tracking, consider first a single scattering event. If $\underline{I}_o$ is the Stokes vector of incident unscattered light, $\underline{\underline{S}}$ is the scattering phase matrix and $\underline{\underline{R}}$ is a rotation matrix which serves to rotate the plane of reference of the Stokes vector into the scattering plane, the Stokes vector after scattering $\underline{I}_f$ is given by

$$\underline{I}_f = R_r \, \underline{\underline{S}} \, \underline{\underline{R}} \, \underline{I}_o$$

where R_r rotates the final Stokes vector into the reference plane of the receiver. After two scatterings, the final Stokes vector will be

$$\underline{I}_f = R_r \, \underline{\underline{S}}_2 \, \underline{\underline{R}}_2 \, \underline{\underline{S}}_1 \, \underline{\underline{R}}_1 \, \underline{I}_o$$

Cast in this way, it is apparent that what is important is the product matrix which is built from the scattering matrices appropriate to the string of scatterings suffered by the photon. This product can be built up either from the left or from the right with the same result; i.e., we may equally well follow the photon's history forward or backwards if we accumulate scatterings properly into the product [which we call the cumulative scattering matrix].

There is a further advantage in tracking backwards: contributions from several solar directions may be accumulated from a single track. For example, if the photon is tracked backwards from the receiver, only the last rotation and scattering contain any reference to solar direction. Replacing one sun by another means changing only these two matrices. For each solar direction, at most, two 4 x 4 matrix multiplications must be performed.

Photons are initialized at the reciever; which may be general in the following ways: it may have finite or infinitessimal (conical) field of view; it may be oriented pointing toward any zenith angle with any azimuthal angle; it may be at any altitude and have any specified x-y coordinate. On the other hand, for flux calculations the receiver aperture may be finite. This is accomplished by letting the receiver be an entire cloud face (any face of any cloud, pointing into or out of the cloud).

First, initial photon coordinates are created. If the receiver is a cloud face, initial photon coordinates are chosen from a uniform distribution over the cloud face. The photon direction is then determined using: 1) uniform distribution over solid angle for a cloud-face receiver, or 2) cosine distribution over the conical field of view of an infinitessimal receiver, or 3) in a specified direction if the field of view

is infinitessimal. For each type of distribution, the appropriate weight is computed (to be multiplied into the sampled values upon sampling).

The distance to be traversed to a scattering is computed on the basis of optical distance to be traversed: if ρ is a uniformly distributed random number, the optical distance to be traversed is given by

$$\tau = - \ln \rho \tag{2.1.1}$$

Through reference to a table containing the optical thickness of each layer of the ambient atmospher and taking into account the added optical density in the interior of clouds, the optical distance traversed and physical distance traversed are incremented until an optical distance τ has been reached. If, before this has occured, the photon exits the atmosphere, the photon is terminated. If the photon strikes the ground, the scattering will be a ground scattering and a ground scattering indicator is set (ISCAT=1).

Having located the position of a scattering, the scatterer type is chosen on the basis of the relative contribution of each scattering species at that point to the local optical density. Here, a cumulative distribution function, which has been tabulated for each layer of the ambient atmosphere, is used in conjunction with any additional optical density due to the presence of a cloud. Photons are not explicitly absorbed. Instead, a weight is accumulated which at any point along the path reflects the probability that the photon has not been absorbed.

After having determined the scatterer type, the probability that the photon could have come from each sun is sampled. If $\underline{\underline{S}}_I$ is the cumulative scattering matrix at the point of sampling, the sampled Stokes vector will be

$$\underline{\underline{I}}_s = \underline{\underline{S}}_I \, \underline{\underline{R}}_j \, \underline{\underline{S}}_j \, \underline{I}_o \, e^{-t_j} \, w \tag{2.1.2}$$

Where R_j is a rotation matrix appropriate to a scattering into the j^{th} solar direction; S_j is a scattering matrix (a Mueller matrix if the scatterer is an atmospheric constituent); I_o is the incident Stokes vector; t_j is the total optical distance along the path connecting the scattering point and sun_j; w is a weight reflecting the probability that the photon has not been absorbed (including ground absorption for Lambertian regions encountered). There will be a different value for w for each Lambertian albedo map. Note that the above form assumes that $\underline{I}_o$ represents intially unpolarized light. If the incident light from the sun were polarized, an additional rotation would be necessary. R_j has the form

$$R_j = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 2X & \sin 2X & 0 \\ 0 & -\sin 2X & \cos 2X & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \tag{2.1.3}$$

where X is the rotation angle between the normal to the previous scattering plane (or the reference direction in the case of first scatterings) and the normal to the scattering plane for a scattering into the j^{th} solar direction. S_j has the general form

$$S_j = \frac{1}{4\pi} \begin{pmatrix} S_{11} & S_{12} & 0 & 0 \\ S_{12} & S_{22} & 0 & 0 \\ 0 & 0 & S_{33} & S_{34} \\ 0 & 0 & -S_{34} & S_{44} \end{pmatrix} \tag{2.1.4}$$

where $S_{\ell,m}$ depends upon scattering angle. For Rayleigh scattering, $S_{11} = S_{22} = \frac{3}{4}(1 + \cos^2 \beta_j)$

$$S_{12} = \frac{3}{4}(\cos^2 \beta_j - 1)$$

$$S_{33} = S_{44} = \frac{3}{2} \cos \beta_j$$

$$S_{34} = 0$$

where β_j is the scattering angle for a scattering into the j^{th} solar direction. For Lambertian scattering at the ground, $S_{11} = 4 \cos \theta_j$, where θ_j is the zenith angle of the j^{th} sun and all other matrix elements are zero. Lambertian reflection thus is perfectly depolarizing.

Mie scattering and Fresnel scattering both have matrices with the form of Eq. (2.1.4). Mie elements are stored in tabular form and values for particular scattering angles are obtained by interpolation. The Fresnel matrix elements are given in the discussion of ground reflectance.

The next step after sampling is to accumulate a "real" scattering. Knowing the scatterer type, an appropriate scattering angle is found. If the scattering angle were chosen from a uniform distribution, and if the scattering matrix appropriate to the medium exhibited sharp peaks, then most photons would rapidly lose weight and large numbers of photon tracks would be necessary in order to achieve a reasonably small variance. To resolve this difficulty, we use the concept of importance sampling. We choose the scattering direction from a biased distribution designed to maximize the resultant contribution. The bias thus introduced is then removed by applying a weight. More concretely, we wish to fold in a scattering matrix

$$S = \begin{pmatrix} S_{11} & S_{12} & 0 & 0 \\ S_{12} & S_{22} & 0 & 0 \\ 0 & 0 & S_{33} & S_{34} \\ 0 & 0 & -S_{34} & S_{44} \end{pmatrix} \frac{dw}{4\pi}$$

$$= \frac{1}{f(\beta)} \begin{pmatrix} S_{11} & S_{12} & 0 & 0 \\ S_{12} & S_{22} & 0 & 0 \\ 0 & 0 & S_{33} & S_{34} \\ 0 & 0 & -S_{34} & S_{44} \end{pmatrix} \frac{f(\beta)\ dw}{4\pi} \qquad (2.1.5)$$

Instead of choosing the scattering angle from a probability distribution corresponding to the probability density $\frac{dw}{4\pi}$ (uniform), we use the distribution corresponding to the probability density $\frac{f(\beta)\ dw}{4\pi}$. The weight of the photon following the scattering can thus be maximized by choosing $f(\beta)=S_{11}$ times a constant chosen so that the first matrix element is always unity. A real scattering is accumulated by multiplying into the cumulative scattering matrix first a rotation, and then the scattering matrix.

The process is repeated until either a designated maximum number of scatterings have been suffered, the photon leaves the atmosphere or its weight drops below the assigned threshold (due, for example, to atmospheric absorption).

2.2 ENCOUNTERS WITH CLOUDS

The presence of finite clouds complicates the evaluation of the fate of the path of the photon in that there is no simple way to determine if a given straight line in space enters a specified rectangular box. It was therefore necessary to undertake an analysis to find optimum procedures for evaluating the path as quickly as possible.

This analysis is applied in two areas of the program:

1. In evaluating the path of the "backward" photon to the "previous" scattering.

2. In computing the probability that a "forward" hypothetical photon would reach a given scattering point from the Sun without scattering.

The problem has been treated in two parts. First, we have found a quick and efficient method for eliminating clouds which could not possibly be entered by the photon path, and secondly, we have performed a detailed analysis to evaluate the uneliminated clouds.

There is a simple method for determining whether it is possible for a straight line to enter a given rectangular cloud. The approach is to circumscribe the cloud with a sphere, the center of which coincides with the center of mass of the cloud. The radius, r, of the sphere can be taken to be $(a^2+b^2+c^2)^{1/2}$ where the lengths of the sides of the cloud are (2a,2b,2c). In this case the eight corners of the box lie on the sphere as illustrated in Figure 2.2.1.

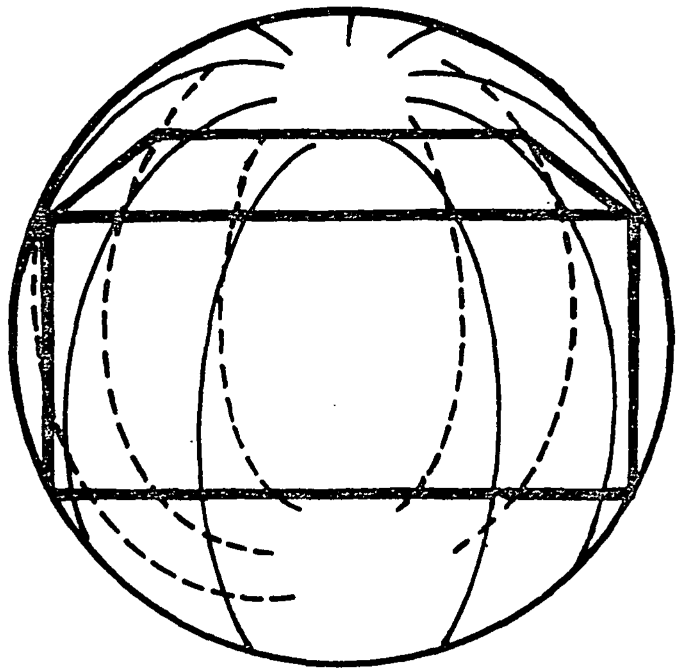


FIGURE 2.2.1. ILLUSTRATION OF CIRCUMSCRIBING SPHERE CONCEPT

Since the sphere completely contains the cloud then if a line cannot enter the sphere, it cannot enter the cloud. Thus, the first check should be to find if the path can enter any cloud circumscribing spheres. We shall present the analysis for a single cloud with the understanding that this must be repeated for all clouds in the program.

Suppose we have a line with direction cosines (c_x, c_y, c_z) leaving a point $A(x_1, y_1, z_1)$. The equation of the line is

$$\frac{x-x_1}{c_x} = \frac{y-y_1}{c_y} = \frac{z-z_1}{c_z} \tag{2.2.1}$$

The distance, R, of the point O (X,Y,Z) from A is

$$R = \{(X-x_1)^2 + (Y-y_1)^2 + (Z-z_1)^2\}^{1/2} \tag{2.2.2}$$

and the point of closest approach of the line to O is such that AP is perpendicular to OP, as illustrated in Figure 2.2.2. Now the cosine of the angle OAP is given by the dot product of the direction cosines of AP and AO; i.e.,

$$\cos OAP = \frac{(X-x_1)c_x}{R} + \frac{(Y-y_1)c_y}{R} + \frac{(Z-z_1)c_z}{R} \tag{2.2.3}$$

But the distance AP is given by R cos OAP; i.e.,

$$AP = (X-x_1)c_x + (Y-y_1)c_y + (Z-z_1)c_z \tag{2.2.4}$$

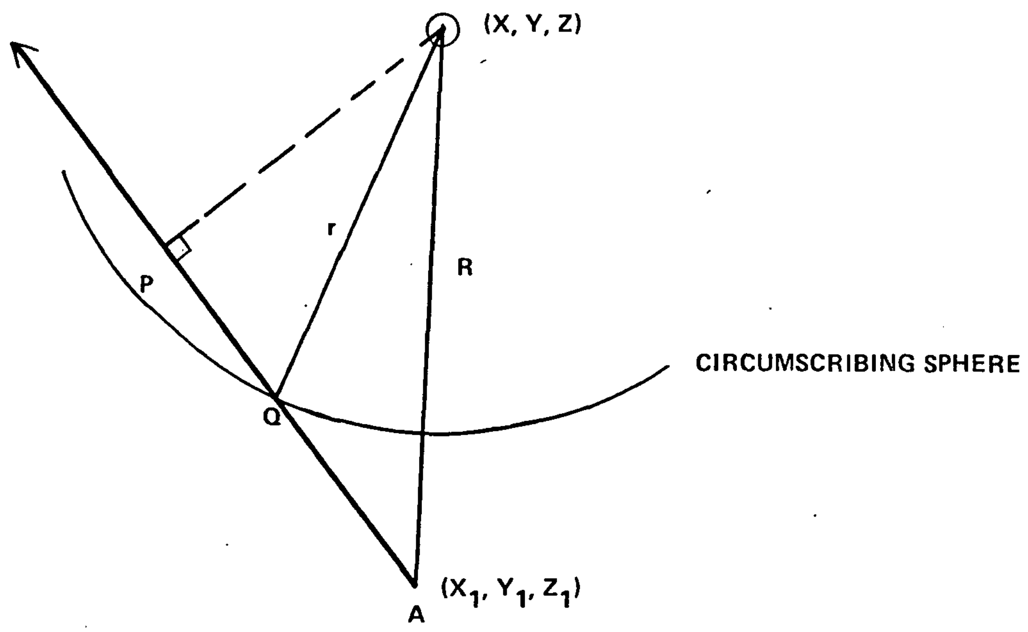


FIGURE 2.2.2. ILLUSTRATION OF POINT OF CLOSEST APPROACH OF A LINE TO A POINT

and by Pythagorus's theorem,

$$OP^2 = R^2 - AP^2$$

$$= R^2 - \{(X-x_1)c_x + (Y-y_1)c_y + (Z-z_1)c_z\}^2 \qquad (2.2.5)$$

Now, if OP^2 is greater than r^2, the squared radius of the circumscribing sphere, then the path cannot enter the sphere. Also, if the quantity in curly parentheses is negative, then again entry is impossible.

Note that OP^2 can be computed in the general coordinate system and that no square roots or complicated functions are necessary for its evaluation.

If we are tracking the path of the backward photon then another check can be made. Although the point of closest approach may be inside the circumscribing sphere, it may be that the length, L, of the path is insufficient to reach the sphere. Suppose, in Figure 2.2.2 that the line reaches the sphere at Q. Then OQ has length r, the radius of the sphere. Now from (2.2.4) and (2.2.5) we are able to evaluate both OP and AP and by Pythagorus's theorem we have that

$$QP^2 = r^2 - OP^2 \qquad (2.2.6)$$

Thus we are able to evaluate the distance to the sphere as

$$AQ = AP - QP \qquad (2.2.7)$$

which may be evaluated by (2.2.4) and (2.2.6). Testing this value against L gives us another possible means of cloud elimination.

We have attempted to use the circumscribing sphere concept further, but we finally concluded that there are some dangers in its further application. For example, the sequence of distances along the path to a cloud need not be the same as the sequence of distances to the circumscribing spheres or the point of closest approach. An illustration of such a case is given in Figure 2.2.3. The reason for the difficulty is that the circumscribing sphere gives no information as to cloud orientation and can therefore mask orientation differences which may be important. For this reason we proceed in the program at this point to a completely general analysis.

The first step in treating an uneliminated cloud is to convert to the coordinate system of the cloud. Thus the location of the scattering point (x_1,y_1,z_1) is transformed to (x_{1c},y_{1c},z_{1c}) using

$$x_{1c} = (x_1-X)\cos\theta_c + (y_1-Y)\sin\theta_c$$

$$y_{1c} = -(x_1-X)\sin\theta_c + (y_1-Y)\cos\theta_c \qquad (2.2.8$$

$$z_{1c} = z_1-Z$$

where θ_c is the orientation angle of the cloud and (X,Y,Z) are the coordinates of the center of mass of the cloud. The direction cosines of the line are transformed to the cloud system using

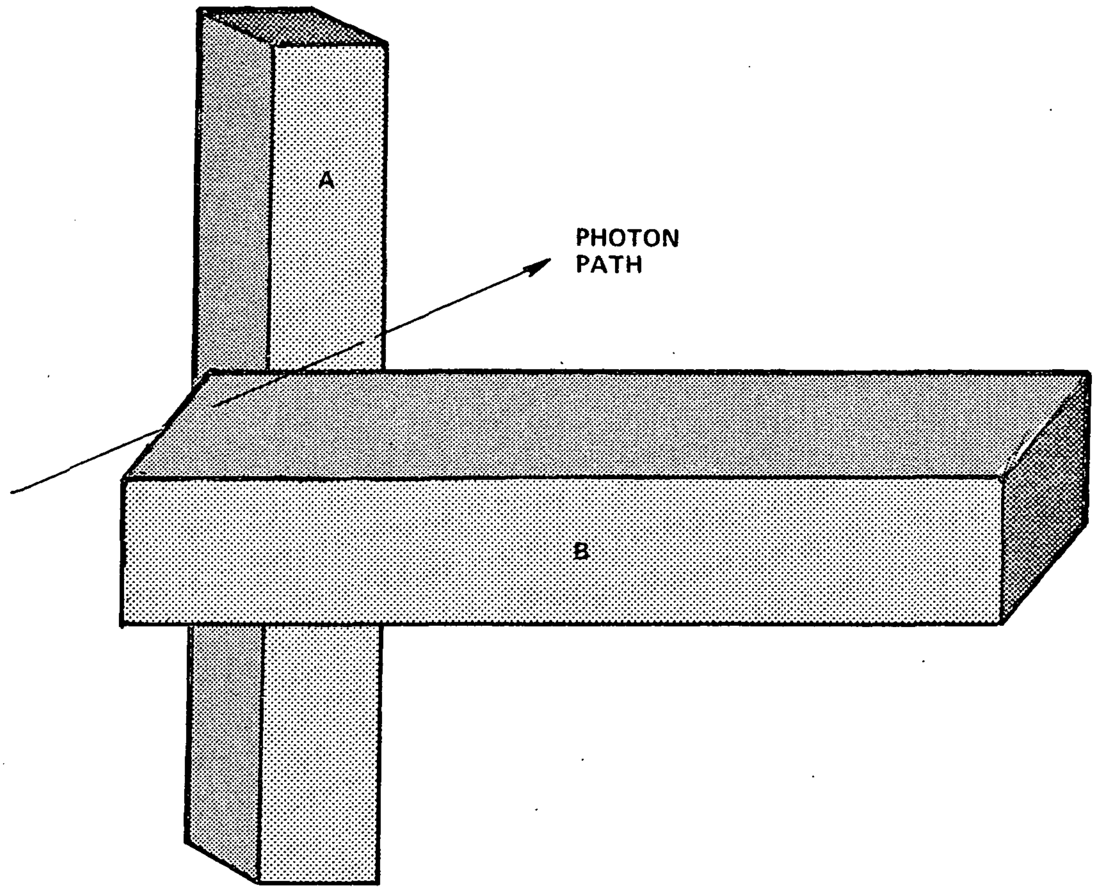


FIGURE 2.2.3. EXAMPLE OF SEQUENCING FAILURE OF CIRCUMSCRIBING SPHERES ALGORITHM

$$C_{cx} = C_x \cos\theta_c + C_y \sin\theta_c$$

$$C_{cy} = -C_x \sin\theta_c - C_y \cos\theta_c \qquad (2.2.9)$$

$$C_{cz} = C_z$$

We shall present the analysis for determining if the photon enters a side perpendicular to the cloud x axis. In the computer program we index terms relating to the cloud x, y and z axes 1, 2 and 3, respectively. The analysis for the sides perpendicular to the y and the z axes can then be performed by merely rotating the ordered index set (1,2,3) to (2,3,1) and (3,1,2), respectively.

The following tests will be performed in sequence.

1. Is $|x_{1c}| \leq a$, the half length of the edges parallel to the cloud x axis. (2.2.10)

   If this condition is satisfied, then the photon cannot possibly enter a face perpendicular to the cloud x axis.

2. If $x_{1c} < -a$, then the path can enter the face $x_c=-a$. In this case, set $q=-a$.

   If $x_{1c} > a$, then the path can enter the face, $x_c=a$. In this case, set $q=a$.

3. Compute $(x_{1c}-q)\cdot C_{cx}$. If this is positive, then the photon is traveling away from the face, $x_c=q$, and will not enter the cloud.

4. Compute the (y_c, z_c) values of the point of intersection of the line with the plane, $x_c=q$. These are given by

$$\left.\begin{aligned} y_{cI} &= y_{1c} + C_{cy} \frac{q-x_{1c}}{C_{cx}} \\ z_{cI} &= z_{1c} + C_{cz} \frac{q-x_{1c}}{C_{cx}} \end{aligned}\right\} \quad (2.2.11)$$

5. Check to see if both the conditions (2.2.12) apply.

$$\begin{aligned} |y_{cI}| &< b \\ |z_{cI}| &< c \end{aligned} \quad (2.2.12)$$

If these are both true, then the photon enters the cloud at the point (q, y_{cI}, z_{cI}). Otherwise, entry does not occur at the x=q plane.

When it is determined that a photon has entered a given cloud then the tracking mechanism from that point on will be performed in the cloud coordinate system.

If it is determined that a later scattering point (x_{1c}, y_{1c}, z_{1c}) lies outside the cloud then we determine the exit point using steps (4) and (5) only.

For evaluating the track of the "forward" hypothetical photon from the Sun to a scattering center we will determine if the direction cosine C_{cxs} of the line from the scattering point to the Sun is positive or negative. (The solar direction cosines (C_{cxs}, C_{cys}, C_{czs}) will be computed for each cloud prior to the simulation.) If C_{cxs} is positive, we set q=a, whereas if it is negative, we shall set q=-a. At this point steps (4) and (4) are employed to find the point of exit from the cloud.

2.3 GROUND SCATTERING

CTRANS has the capability to model reflections from a spatially inhomogeneous ground. In the present version of the code, the physical mechanism of reflection may be modeled as either Lambertian reflection or as Fresnel reflection from a rough surface and these modes may be intermixed in a patchwork fashion.

Reflectance type is basically controlled by a reflectance type map which dictates the reflectance character from point to point across the infinite ground plane. When a photon strikes the ground, its impact coordinates are computed and then used to decide whether the point of impact was within a Lambertian or a rough Fresnel region.

Since Lambertian reflection is not physically dependent upon the direction of incidence or reflection but only upon a scalar Lambertian albedo, CTRANS can model simultaneously the effect of several values (up to 50) of the albedo for each of the Lambertian regions. This is accomplished in the following way: A vector of scalar weights is maintained; one for each albedo map. When a Lambertian scattering occurs, the albedo at the point of impact is determined for each of the albedo maps and this is multiplied into the corresponding albedo weight to obtain a new weight for subsequent use. Upon sampling, each current albedo weight is folded into the sampled Stokes vector to obtain samples corresponding to each of the allowed albedo maps. If the impact point lies within a Fresnel region, however, the vector of albedo weights is left unchanged (since it represents the cumulative effects of only the Lambertian regions).

Symbolically, the entire reflection process is as follows: given an old cumulative scattering matrix S_o, the new one, S_N, is computed as:

$$S_N = S_o R s$$

where R is a rotation matrix and s depends upon the reflectance type at the impact point:

$$\text{Lambertian} \qquad s = \begin{pmatrix} \cos\theta & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\text{Fresnel} \qquad s = \begin{pmatrix} S_{11} & S_{12} & 0 & 0 \\ S_{12} & S_{11} & 0 & 0 \\ 0 & 0 & S_{33} & 0 \\ 0 & 0 & 0 & S_{33} \end{pmatrix}$$

where S_{ij} represent Fresnel matrix elements:

$$S_{11} = (R_{11}{}^2 + R_1{}^2)/2$$

$$S_{12} = (R_{11}{}^2 - R_1{}^2)/2$$

$$S_{33} = R_{11} R_1$$

and

$$R_{11} = \frac{n \cos \chi_i - \cos \chi_t}{n \cos \chi_i + \cos \chi_t}$$

$$R_1 = \frac{\cos \chi_i - n \cos \chi_t}{\cos \chi_i + n \cos \chi_t}$$

n = relative index of refraction of the surface

χ_i = angle of incidence

χ_t = angle of refraction, computed from χ_i through Snell's law at the interface: $n \sin \chi_t = \sin \chi_i$.

The vector of scalar weights is renewed according to

$$A_i^{new} = A_i^{old} \times a_i(J;X,Y)$$

X,Y = coordinates of impact point

J=0 = region is Lambertian and the values of $a_i(i=1,50)$ are determined from the Lambertian albedo maps according to the coordinates (X,Y)

J=1 = region is Fresnel $a_i = 1(i=1,50)$.

The two kinds of ground maps (Lambertian albedo maps and the reflectance type map) are specified in CTRANS in two different ways.

The Lambertian albedo maps are specified in a fixed form by the subroutine ALBEDO. To change albedo map structures one version of ALBEDO is interchanged with another. The possible variety of maps is thus limited only by the imagination. ALBEDO, in addition to its function of providing specific values of the scalar weights at a specified point has the function of writing out text to describe the various maps.

The reflectance type map is specified by options read in by subroutine INPUT and is therefore less flexible than the albedo maps. As options, the following choices are presently available:

1) Uniform plane.

2) Adjoining half planes of different reflectance type bounded by a line parallel to the y-axis whose position is specifiable by its x-coordinate.

3) Non-overlapping rectangles set upon a uniform background (up to 20 such rectangles are allowed).

In all of the above, the background is specifiable as either Lambertian or rough Fresnel with inhomogeneities having either rough Fresnel or Lambertian character, respectively. The rectangles are specified by the (X,Y) coordinates of their centers and their X-Y edge lengths.

Text describing the chosen pattern is written out by INPUT. A cautionary note is in order here. Since the two types of maps are specified by unrelated means, care must be taken in the interpretation of results: The Albedo maps only apply to regions specified to have Lambertian character. Thus, using 50 varigated albedo maps and specifying the reflectance type map as a uniform rough Fresnel plane would produce identical results for all 50 albedo maps.

For rough Fresnel regions, the roughness is characterized as a distribution of randomly oriented sloping plane facets. The probability density for the distribution of slopes was chosen to have two-dimensional Gaussian form. $p(Z_x, Z_y) \times \delta Z_x \ \delta Z_y$ is the fraction of a small horizontal unit area of surface for which the x,y components of the slope are within the limits $Z_x \pm \frac{1}{2} \delta Z_x$ and $Z_y \pm \frac{1}{2} \delta Z_y$. We specify $p(Z_x, Z_y)$ as:

$$p(Z_x, Z_y) = (\pi\sigma^2)^{-1} \exp\left[-(Z_x^{\ 2} + Z_y^{\ 2}) / \sigma^2\right]$$

The variance, σ^2 is specified either by three parameters W0, W1, W; or as a set value specified on input. When specified through parameters, σ^2 is given as

$$\sigma^2 = W0 + W1 \times W$$

W represents wind speed (m/sec) in a model for the surface of the sea[1)] and W0, W1 have either their default values (W0 = .0015, W1 = 2.54×10^{-3}) or values specified by card input. In the present code, all rough Fresnel regions share the same parametric values. This restriction could be relatively easily relaxed if desired.

The above form for $p(Z_x, Z_y)$ represents that applicable for a photon incident from the vertical. For photons incident from some other direction, the distribution must be modified. Let the photon's direction be given by unit vector $\hat{k}$, the direction of the normal to a facet be $\hat{n}$, and the vertical direction be $\hat{Z}$. The probability of encounter will then be given by:

$$\frac{\hat{k}\cdot\hat{n}}{(\hat{n}\cdot\hat{Z})(\hat{k}\cdot\hat{Z})} \; p(\hat{n}) \; .$$

Having determined a slope at the photon impact point, the angle of incidence and, thence, the Fresnel matrix elements can be determined. If k and k' are the directions of propagation of the incident and reflected photons, their relation to n is

$$\frac{\hat{k}' - \hat{k}}{|\hat{k}' - \hat{k}|} = \hat{n} \; .$$

When sampling the contributions of unscattered photons from the Sun at a Fresnel scattering point, the direction of reflection is given by the solar direction and one merely evaluates the probability of having encountered a slope having the proper orientation. Note that in the present model the location of the Sun is given by a Dirac delta function (incoming plane waves) rather than being spread over a small angular region. The implied integration over the solar direction (or, equivalently, the change of variables within the delta function specifying the solar direction) introduces an additional factor of

$$.25 \; (\hat{n}\cdot\hat{Z})^{-3} \; (k\cdot\hat{n})^{-1}$$

Our present formulation does not properly account for shadowing (waves whose surfaces are inaccessible due to their orientation) or for hiding (slopes inaccessible because of intervening higher waves). Thus, we expect some systematic bias, especially when either the sun or the receiver is low in the sky.

SECTION 3.0
TESTING: CAPABILITIES AND LIMITATIONS OF CTRANS

CTRANS has been tested and validated through comparison with the results of other calculations under a variety of conditions. Here, the results of representative cases will be presented and discussed.

The basic functional structure of the Monte Carlo code (backwards-tracking algorithm, Lambertian ground reflection, statistical normalizations, etc.) may be tested via calculations of radiative transfer through a pure Rayleigh atmosphere and comparison with the well established results of Coulson, Dave, and Sekera.[2)] Next, the atmosphere is made more complicated by adding layered structure and additional active atmospheric species. This provides a basic test of the algorithms for scatterer selection, the treatment of absorption, and the treatment of polydispersions. There may be special problems associated with optically thick atmospheres composed of strongly anisotropic scatterers so this case is of interest.

CTRANS' capacity to handle horizontal inhomogeneities is basically evaluated by means of a calculation with a single cloud in the atmosphere and comparison with the results of McKee and Cox.[3)] In this test, some difficulties were detected which are associated with the calculation of flux (in optically thick clouds) by means of a backwards tracking code. These difficulties are partially resolved by using a specially adopted forwards-tracking code which will be briefly described.

CTRANS' capacities to treat horizontal ground reflection inhomogeneities are presented through test results. Absolute validation is difficult here in the absence of dependable analytical results, but having validated the microscopic reflection mechanism (through the inspection of results for uniform ground planes) only problems associated with the statistical density of sampling might be present. These statistical problems may be detected through the comparison of results from statistically independent runs.

3.1 HORIZONTALLY HOMOGENEOUS ATMOSPHERES

The first and most basic test case is that for a horizontally (and vertically) homogeneous Rayleigh atmosphere. Here CTRANS results may be compared with those of Coulson, Dave and Sekera [2)] who have tabulated values for the Stokes parameters and polarization for Rayleigh atmospheres with optical thicknesses ranging up to 1.0 and for uniform Lambertian ground planes with albedos from 0.0 to 0.8.

We have run tests over a range of optical thicknesses. Of these, the most stringent test is provided by the largest optical thickness ($\tau = 1$). Since, in this case, single scattering, multiple scattering and ground reflection all are relatively important. Typical results for I, Q, U, and the polarization are shown in Figures 3.1.1 through 3.1.4. These results are for a receiver on the ground looking up with a zenith cosine angle of 0.4, 60° from the solar-vertical plane. As can be seen, agreement is excellent both for zero ground albedo and high ground albedo (0.8). Thus reflections at the ground are handled properly as is the basic transport through the atmosphere.

FIGURE 3.I.I.
I VS. SOLAR ZENITH COSINE

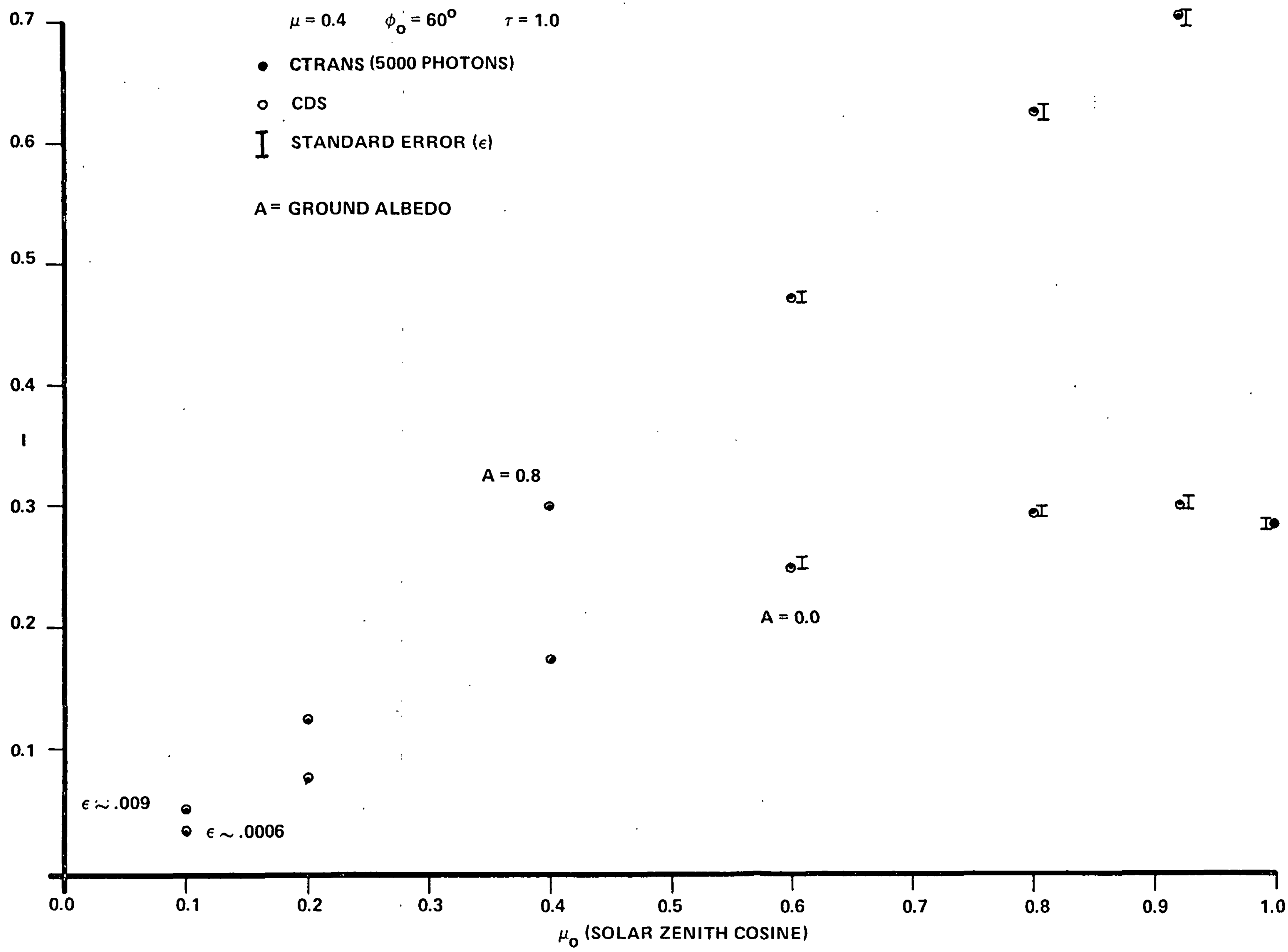


FIGURE 3.1.2.
Q VS. SOLAR ZENITH COSINE

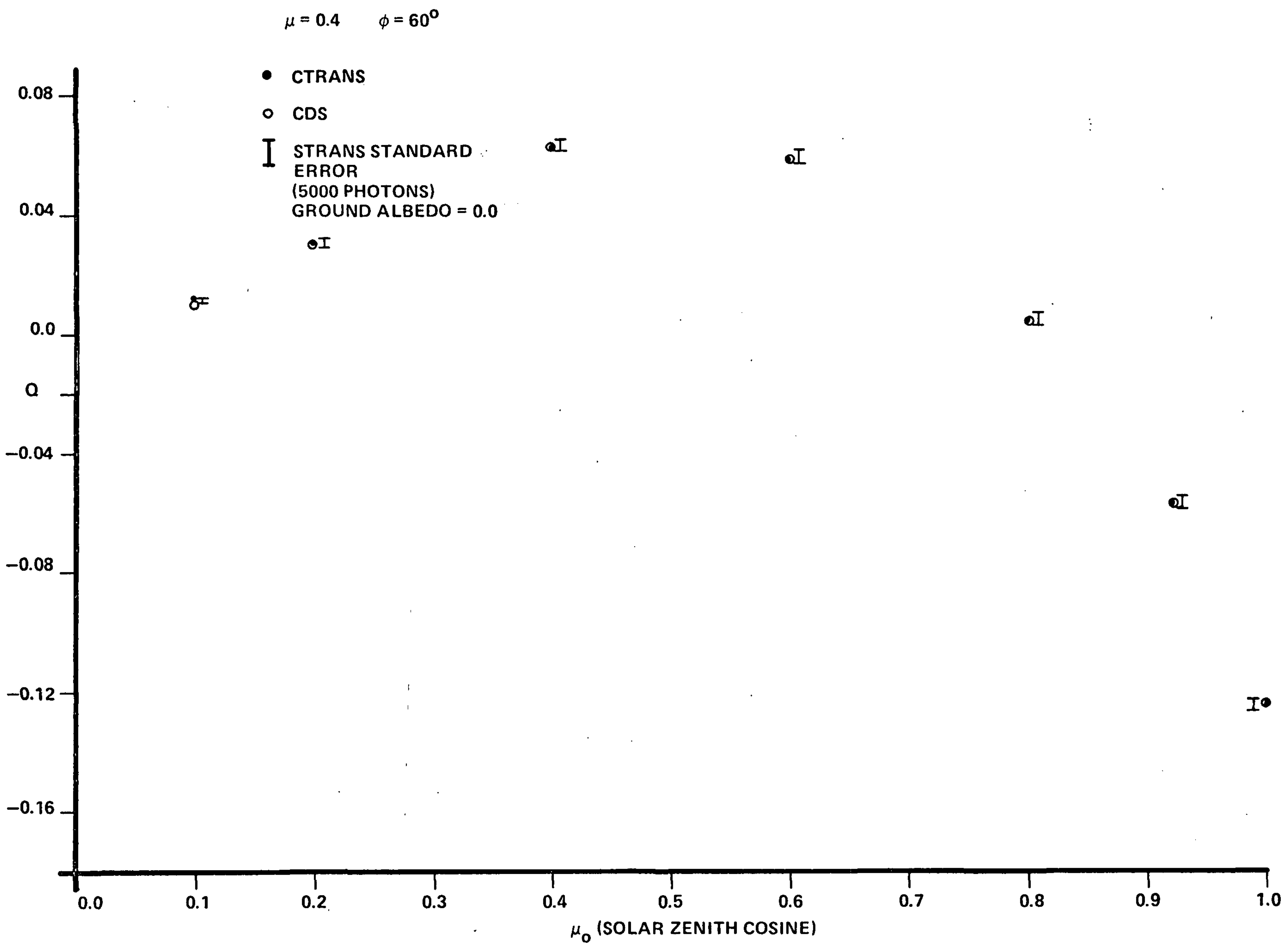


FIGURE 3.1.3
U VS. SOLAR ZENITH COSINE

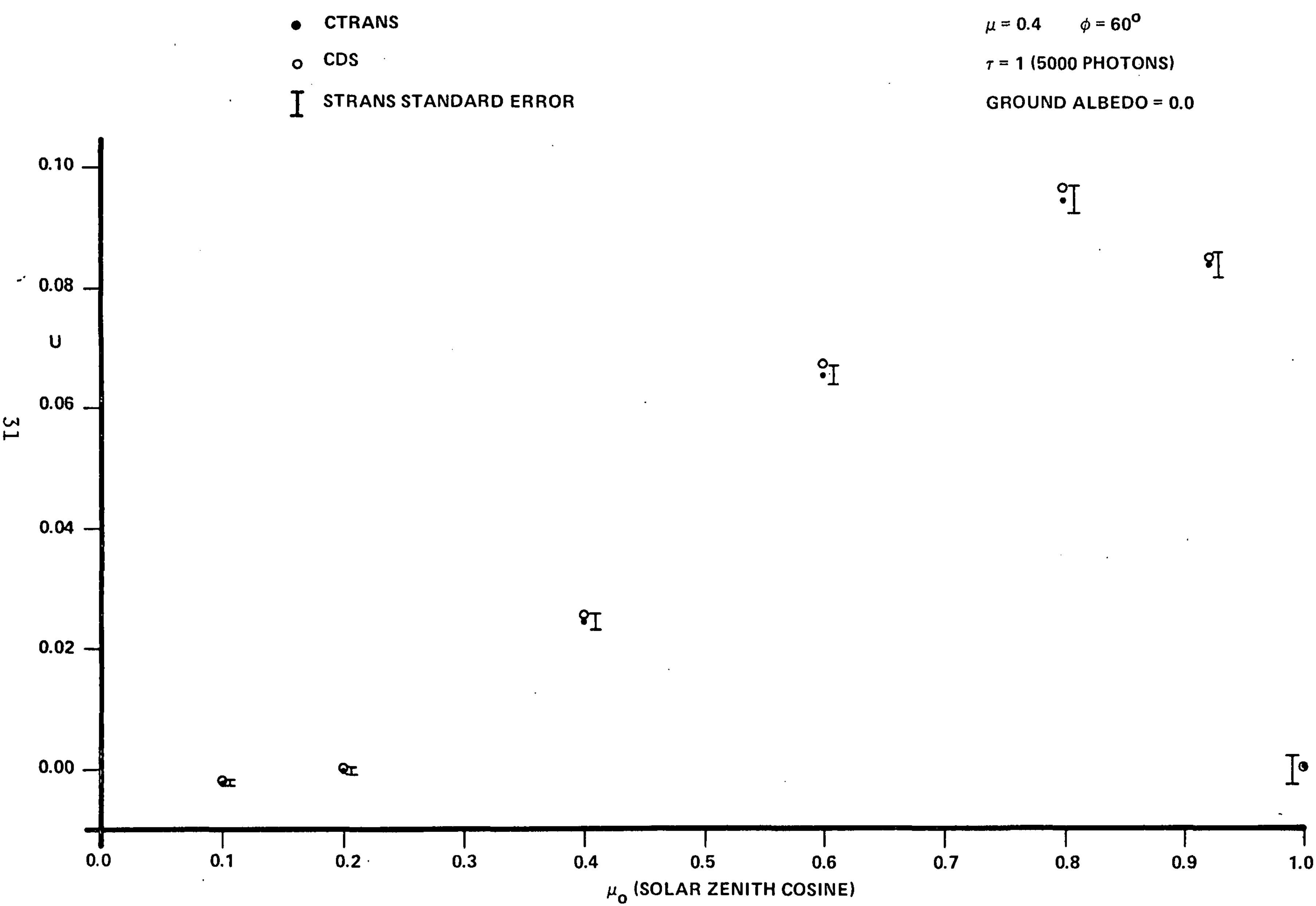
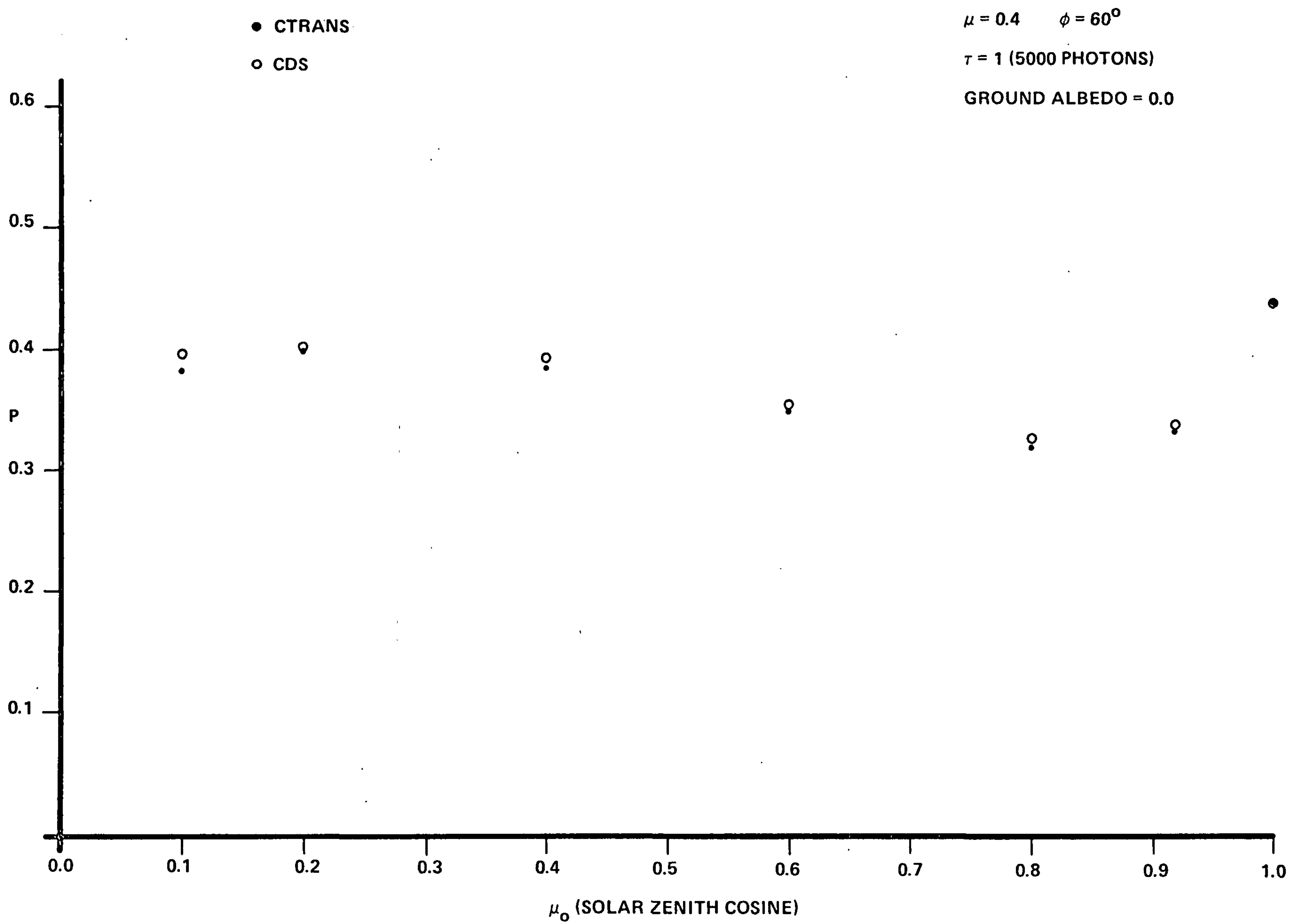


FIGURE 3.1.4.
P VS. SOLAR ZENITH COSINE



In the next test, we add vertical structure and a polydisperse aerosol in a fairly realistic model of a clear atmosphere. Since analytical results are unavailable for such an atmosphere, we compare CTRANS' computed values with two sets of results kindly provided by Dr. R.S. Fraser (computed by programs named RADTRAN and VPD). Results are presented in Tables 3.1.1 and 3.1.2 for the intensity and polarization at the bottom and the top of the atmosphere. As may be seen, CTRANS is in agreement with both routines to within the bounds expected from CTRANS' computed standard errors.

CTRANS may encounter difficulty in handling optically thick atmospheres composed of scatterers having an extremely peaked phase function such as is provided by a Deirmandjian C1 polydispersion. The manifestation of the problem is a rather large variance especially evident when computing the radiance for a receiver looking down into the atmosphere. Tables 3.1.3 and 3.1.4 provide an illustration of the effect. Here we present a test case for a receiver pointing towards the nadir from the top of the atmosphere. The atmosphere is composed of pure Mie scatterers (C1 Deirmendjian haze: $\alpha = 6.0$, $\beta = 1.5$, $\gamma = 1.0$, index of refraction = 1.5). The wavelength is 0.825 microns. In the tables, I_c refers to CTRANS' results; I_k are results computed by a doubling method (provided by Mr. Lee Kyle); and SE_c denotes the standard error inherent in I_c. For this case, the ground albedo was zero and polarization was neglected. As may be seen, the agreement between I_c and I_k for the $\tau = 0.1$ case is acceptable. However, when the optical thickness is increased to $\tau = 10.0$, the variance rises markedly (though no bias is detected). This variance is extremely difficult to reduce; particularly for the $\tau = 10.0$ case. Here 2000 photons were tracked and up to 50 scatterings allowed per track, resulting in 39,422

Table 3.1.1. Realistic Clear Atmosphere Test: Intensity

RECEIVER θ	ϕ	Height (Km)	CTRANS I_C		Std.Error (sec)	RADTRAN I_R	$\frac{I_C - I_R}{\text{sec}}$	VPD I_{VPD}	$\frac{I_C - I_{VPD}}{\text{sec}}$
60	0	0	.076158	$\pm$	.00108	.07660	-.41	.07569	+.43
60	180	0	.024003	$\pm$	.000488	.02359	+.85	.02405	-.09
36	0	0	.13846	$\pm$	.002537	.13947	-.40	.1361	+.93
36	180	0	.026063	$\pm$	.000549	.02682	+.44	.02596	+.19
60	0	70	.021629	$\pm$	.000415	.02128	+.84	.02190	-.65
60	180	70	.026991	$\pm$	.000504	.02623	+1.52	.02735	-.70
36	0	70	.014557	$\pm$	.000362	.01396	+1.65	.01455	+.02
36	100	70	.021593	$\pm$	.000514	.02098	+1.19	.02180	-.40

Wavelength λ=0.55 μm

Solar Zenith Angle = 22°

Number of Atmospheric Layers = 34

Total Rayleigh Optical Thickness τ_R=0.098

Total Aerosol Optical Thickness τ_A=0.19643

Aerosol Index of Refraction m=1.5

Aerosol Size Distribution $n(r)=0 \quad r<.03$

$=C \quad .03\le r<.2$

$=C\ r^{-4} \quad .2\le r$

Number of Photons per Receiver = 10^4

Maximum Scatterings per Photon Track = 20

Total Execution Time (CPU Time) = 2.66 min.

Table 3.1.2. Realistic Clear Atmosphere Test: Polarization

RECEIVER			CTRANS			RADTRAN		VPD	
θ	φ	Height (Km)	P_C		Std.Error (sec.)	I_R	$\frac{P_C-P_R}{sec}$	P_{VPD}	$\frac{P_C-P_{VPD}}{sec}$
60	0	0	.06398	±	.00194	.06144	1.31	.0644	-.22
60	180	0	.50488	±	.01497	.4990	.39	.5126	-.52
36	0	0	-.000905	±	.00076	.008	-2.24	.0010	-2.51
36	180	0	.23289	±	.0081	.2402	-.90	.2502	-2.14
60	0	70	.58006	±	.0163	.5842	-.25	.5966	-1.01
60	180	70	.16338	±	.0114	.1515	+1.04	.1546	+.77
36	0	70	.39195	±	.0151	.3970	-.33	.4037	-.78
36	180	70	-.02306	±	.0052	-.01838	-.90	-.0157	-1.42

Wavelength λ=0.55 μm

Solar Zenith Angle=22°

Number of Atmospheric Layers=34

Total Rayleigh Optical Thickness τ_R=0.098

Total Aerosol Optical Thickness τ_A=0.19643

Aerosol Index of Refraction m=1.50

Aerosol Size Distribution $n(r)=0 \quad r<.03$ μm

$=C \quad 0.03 \le r \le 0.2$

$=C\ r^{-4} \quad .2 \le r$

Number of Photons per Receiver=10^4

Maximum Scatterings per Photon=20

Total Execution Time (CPU)=2.66 min.

Table 3.1.3. Uniform Aerosol Test $\tau=0.10$

SOLAR ZENITH	CTRANS			KYLE			PERCENT ERROR
Angle θ_0	Intensity I_C		Std.Error SE_C	Intensity I_K	$\frac{I_C-I_K}{sec}$	$\frac{SE_C}{I_C} \times 100\%$	$\frac{I_C-I_K}{I_K} \times 100\%$
0	.00660	$\pm$	.00014	.00699	-2.77	2.1	-5.6
4	.01398	$\pm$	.00024	.01415	-.59	2.1	-1.2
12	.00467	$\pm$	.00017	.00472	-.32	3.1	-1.1
15	.00620	$\pm$	.00084	.00534	+1.02	13.6	+16.0
30	.000818	$\pm$	.000034	.000812	+.17		+0.7
45	.000368	$\pm$	.000020	.0003726	+.21		+1.1
60	.000360	$\pm$	.000017	.0004017	-2.47		-10.5

Atmosphere: Uniform Aerosol 5 Km Thick

Aerosol Size Distribution: Deirmendjian C1

$\alpha=6.0$, $\beta=1.5$, $\gamma=1.0$

Aerosol Index of Refraction $m=1.5$

Total Vertical Optical Thickness $\tau=0.10$

Wavelength $\lambda=0.825$ μm

Receiver Nadir Angle=0°

Receiver Altitude = 5 Km (Top of Atmosphere)

Number of Photon Track = 22000

CPU Time = 1.51 min.

Table 3.1.4. Uniform Aerosol Test τ=10.0

SOLAR ZENITH	CTRANS			KYLE			PERCENT ERROR
Angle θ_0	Intensity I_C		Std.Error SE_C	Intensity I_K	$\frac{I_C - I_K}{sec}$	$\frac{SE_C}{I_C}$ x 100%	$\frac{I_C - I_K}{I_K}$ x 100%
0	.28179	$\pm$	.07461	.2434	.51	26.5	15.8
4	.26818	$\pm$	.03061	.2858	-.58	11.4	-6.2
12	.18665	$\pm$	.02554	.2067	-.79	13.7	-9.7
15	.17177	$\pm$	.01998	.2076	-1.79	11.6	-17.3
30	.15409	$\pm$	.03187	.1459	+.26	20.7	5.6
45	.12780	$\pm$	.05169	.1132	+.28	40.4	12.9
60	.07365	$\pm$	.01862	.07631	-.14	25.3	-3.5

Atmosphere: Uniform Aerosol 5 Km Thick

Aerosol Size Distribution: Deirmendjian C1 (α=6.0, β=1.5, γ=1.0)

Aerosol Index of Refraction m=1.5

Total Vertical Optical Thickness τ=10.0

Wavelength λ=0.825 μm

Receiver Nadir Angle = 0°

Receiver Altitude = 5 Km (Top of Atmosphere)

Number of Photon Tracks = 2000

Maximum Scatterings per Photon = 50

CPU Time = 5.10 min.

scattering events (19.71 scatterings per photon track on the average). Tracking 2000 photons in this thick atmosphere required 5.10 minutes of CPU time. The variance might be reduced by increasing the number of photon tracks, but in general this would be very expensive. There are two effects operating in the $\tau = 10$. Case: 1) Since the atmosphere is thick, photons must scatter many times before wandering out of the atmosphere. 2) The fact that the scattering phase function is extremely peaked in the forward direction means that most photons will not contribute importantly to the sample; i.e., only a few photons which, by chance, are traveling nearly toward the sampling direction provide large contributions to the sample while all others contribute small amounts. The backwards tracking code is thus statistically inefficient in this case. This inefficiency may be unimportant in optically thin atmospheres (or in absorbing atmospheres) since it may be economically overcome by increasing the number of photon tracks.

In an attempt to improve the efficiency of the code, a number of alternate importance sampling schemes were implemented. In all of these, it was found that any substantial reduction in variance was accompanied by the introduction of bias. These alternate schemes have, thus, been abandoned.

3.2 HORIZONTAL ATMOSPHERIC INHOMOGENEITIES (CLOUDS)

In order to validate CTRANS' capacity to handle finite clouds, we may compare with the results of McKee and Cox.[3)] Their computation utilized a Monte Carlo method to calculate the flux emerging from the faces of a finite cloud of cubic shape. Their model ignored scattering outside the cloud and neglected polarization effects. Accordingly, we used no ambient atmosphere and restricted the ground to zero albedo.

McKee and Cox obtained results for clouds composed of an aerosol having a Deirmendjian haze C1[5] size distribution and optical thickness per kilometer equal to 4.9 and 73.5. The wavelength is 0.45 μm.

The scattering phase function for this case contains a very narrow, strong forward peak. Our previous considerations would lead us to expect that these clouds would provide a very severe test of CTRANS. Optically thick clouds entail many scatterings per photon track and a sharply peaked phase function requires many independent photon tracks to achieve satisfactory variance. On this account, we have restricted the test to a cloud with an optical thickness of 4.9 per kilometer.

The basic geometry of the test is illustrated in Figure 3.2.1. Light is incident upon the cloud from zenith angles of 0°, 30°, and 60°. The incident flux is normalized to 1 watt/km^2 normal to the beam.

In order to compare with McKee and Cox, CTRANS (using backward tracking) initiates photons from a chosen face of the cloud, distributing them uniformly over the face and distributing their initial flight directions over 2π steradians. In so doing, CTRANS might be expected to incur additional variance since some regions of the cloud will be brighter than others and some exit directions will be more important. This, then, will represent an additional source of difficulty for the backwards tracking method. For this test, separate computations are performed for each face. This means that flux will not be automatically conserved and the degree to which flux is conserved will be a test of the program.

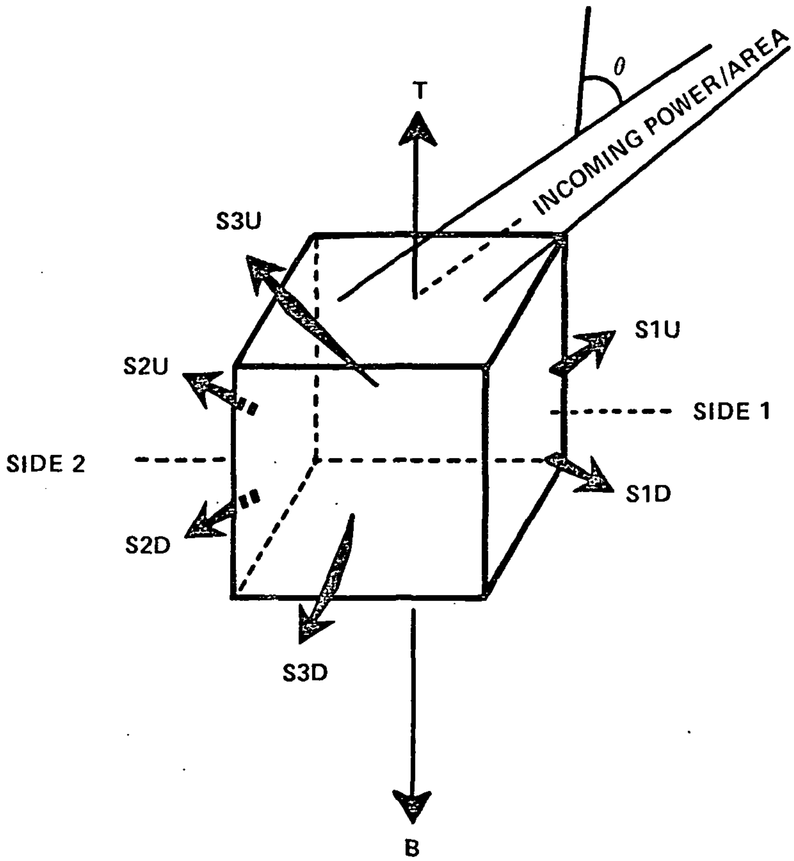


FIGURE 3.2.1. GEOMETRY OF THE COX-McKEE TEST CLOUD

When photons are initiated on a face, they are segregated according to whether the (forward) photon would be emerging upwards or downwards. CTRANS' results for the fraction of incident flux emerging from each face upwards or downwards are compared with those of McKee and Cox in Table 3.2.1 for each face for upward-emerging and downward-emerging photons. Results for all three solar zenith angles are computed simultaneously so that there will be some correlation between results for different suns; suns at 30° and 60° correlate most strongly.

From the results of Table 3.2.1, the conservation of flux can be checked: for solar zenith angles, 0°, 30°, and 60°, the total emerging flux is .946 $\pm$ .12, .98 $\pm$ .14, and 1.29 $\pm$ .25. In each case, the difference from 1.0 is not statistically significant.

Overall, the results for individual faces tend not to be as accurate as might be desired. For a number of faces, the difference between CTRANS' results and those of McKee and Cox is large compared with the computed standard error and in most of these instances, CTRANS' results are low. This may be caused indirectly by photons escaping from the cloud before they have added their full proper contributions to the flux. Two possibilities exist for correcting this: keep the photons in the cloud and accumulate the probability that they would have escaped; or run many more photons. The first method precludes interaction with the atmosphere surrounding the cloud and with other clouds and is therefore generally undesirable for CTRANS. The second method will only be feasible for optically thin clouds. One other possibility exists which has not yet been fully explored: distribute the photons non-uniformly over the cloud face initially.

TABLE 3.2.1. FLUX EMERGING FROM THE FACES OF A CUBIC CLOUD

CLOUD VERTICAL OPTICAL THICKNESS = 4.9
CLOUD COMPOSITION: C1 DEIRMENDJIAN
[n (r) $\sim r^6 \exp(-1.5\, r)$]

WAVELENGTH λ = 0.45 μm

NUMBER OF PHOTONS TRACKED = 4000/FACE
NO AMBIENT ATMOSPHERE
GROUND ALBEDO = 0.0

θ_o		T	S1U	S2U	S3U	TOTAL UP	B	S1D	S2D	S3D	TOTAL DOWN
	INCIDENT	1.00									
	DIRECT (CTRANS)						.0074566				
	(EXACT)						.0074650				
0°	SCATTERED (CTRANS)	.0561 ± .003	.0163 ± .003	.0165 ± .003	.0167 ± .003	.120 ± .006	.2747 ± .028	.1972 ± .112	.0873 ± .012	.1282 ± .028	.816 ± .13
	(COX–McKEE)	.08	.02	.02	.02	.17	.41	.10	.10	.10	.82
	INCIDENT	.63	.37								
	DIRECT (CTRANS)						.06618 ± .002		.06633 ± .002		
30°	(EXACT)						.06543		.064497		
	SCATTERED (CTRANS)	.041 ± .002	.0187 ± .002	.0162 ± .002	.0122 ± .002	.101 ± .005	.430 ± .135	.0252 ± .002	.1801 ± .030	.0560 ± .004	.748 ± .14
	(COX–McKEE)	.05	.02	.02	.02	.13	.33	.03	.25	.07	.74
	INCIDENT	.37	.63								
	DIRECT (CTRANS)						.06494 ± .0013		.06862 ± .002		
60°	(EXACT)						.064497		.06543		
	SCATTERED (CTRANS)	.0428 ± .002	.0227 ± .002	.201 ± .109	.0211 ± .003	.309 ± .11	.4351 ± .212	.0234 ± .008	.2939 ± .094	.0459 ± .003	.844 ± .23
	(COX–McKEE)	.05	.03	.05	.02	.19	.26	.02	.27	.06	.68

This is tricky, however, as great care must be employed to avoid introducing bias in the final result. Further, a suitable non-uniform distribution would be expected to depend upon the solar zenith angle, thus limiting runs to a single sun. The logical extension of this concept would be to attempt to distribute photons both in position and direction according to their importance in the final results. Initial effort along this line were not notably successful and have not been pursued.

3.3 FLUX COMPUTATIONS FOR A FINITE CLOUD COMPUTED BY A FORWARD TRACKING PROGRAM

Our experience in applying the backward tracking Monte Carlo program to the evaluation of fluxes emanating through the faces of finite clouds demonstrated that there is considerable difficulty in establishing relevant importance functions which provide unbiased solutions with low variance. A more natural procedure for evaluating the fluxes through the faces of a single cloud is to use the forward tracking procedure of Cox and McKee.

In order to provide a means of testing flux results generated by the backwards code we modified an existing forward tracking code for a plane parallel atmosphere using subroutines developed for the backtracking code. The code was tested by regenerating some of the results of Cox and McKee.

The flux evaluation code, FLX, provides a capability in simulation capacity that exceeds that of the Cox and McKee code. The salient features of the simulation are as follows:

1. Only one box-shaped cloud can be treated. Its interactions with the surrounding atmosphere, other clouds and the ground are neglected. The cloud must have its upper and lower surfaces parallel to the ground. Its shape need not be cubic.

2. The cloud can have arbitrary azimuthal orientation, i.e., it is not necessary for there to be a pair of faces parallel to the solar zenith plane.

3. Vertical inhomogeneities within the cloud are allowed. Up to 100 vertical layers may be defined with up to 5 scattering species.

4. Polarization is treated using the Mueller scattering algebra.

In brief, the photon tracking and sampling algorithm is as follows:

A photon enters a face of the cloud in a random location. The face of entry is selected on the basis of the area of the face projected perpendicular to the solar direction. At each scattering we compute the face towards which the photon is travelling using the subroutine CLOUT described elsewhere in this report and evaluate the optical thickness τ_i to the face. We then sample the quantity

$$S_i = w_i I_i e^{-\tau_i}$$

where w_i = weight of the photon at the ith scattering

and I_i = intensity component of Stokes vector at ith scattering as the contribution to the appropriate flux.

The photon weight is then reduced by a fraction $(1 - e^{-\tau_i})$, i.e.,

$$w_{i+1} = w_i (1 - e^{-\tau_i})$$

and the photon is forced to make its next scattering prior to exit from the cloud. If τ_{i_s} is the actual optical distance to the next scattering then τ_{i_s} is distributed as $e^{-\tau}$ but with the constraint that $\tau_{i_s} < \tau_i$.

The sampled fluxes from the sides of the cloud are discriminated in terms of up-welling and down-welling photons. Obviously, only upwelling photons contribute to the flux from the upper face of the cloud and only downwelling photons contribute to the flux from the lower cloud face. By treating the point of entry to the cloud as a scattering point we are able to properly evaluate the flux contribution of attenuated but unscattered solar radiation contributing to the flux.

Each photon is tracked until its weight is reduced to an arbitrary threshold. Typically we have set the threshold at 10^{-5}. A typical simulation would involve 1000 to 10000 incident photons and standard errors in the fluxes range from 1 to 5 percent.

	θ	τ	TINF	T	S1U	S2U	S3U	TOTAL UP	BINF	B	S1D	S2D	S3D	TOTAL DOWN
INCIDENT				1.0	0									
SCATTERED	0	4.9	.222 ±.012	.066 ±.007	.026 ±.004	.026 ±.004	.026 ±.004	.171 ±.010	.771 ±.012	.395 ±.009	.108 ±.009	.108 ±.009	.108 ±.009	.829 ±.010
		73.5	.877 ±.019	.512 ±.022	.051 ±.009	.051 ±.009	.051 ±.009	.716 ±.020	.118 ±.016	.016 ±.006	.068 ±.010	.068 ±.010	.068 ±.010	.287 ±.018
INCIDENT				.63	.36									
SCATTERED	30	4.9	.292 ±.013	.048 ±.006	.031 ±.005	.020 ±.003	.019 ±.003	.138 ±.009	.705 ±.013	.313 ±.014	.026 ±.004	.249 ±.013	.072 ±.007	.862 ±.009
		73.5	.913 ±.016	.392 ±.022	.110 ±.013	.026 ±.006	.045 ±.008	.618 ±.021	.091 ±.015	.079 ±.012	.118 ±.013	.061 ±.010	.060 ±.009	.378 ±.019
INCIDENT				.36	.63									
SCATTERED	60	4.9	.470 ±.015	.056 ±.006	.033 ±.005	.058 ±.006	.032 ±.004	.212 ±.011	.530 ±.015	.238 ±.013	.026 ±.004	.264 ±.013	.065 ±.007	.788 ±.011
		73.5	.915 ±.016	.286 ±.020	.164 ±.015	.021 ±.007	.047 ±.008	.565 ±.021	.089 ±.016	.106 ±.014	.191 ±.016	.035 ±.008	.058 ±.010	.447 ±.021

Table 3.3.1 presents a comparison of the flux fractions emanating from the various faces of the cloud. Contributions from unscattered light have been added into the diffuse contribution in computing the total downwelling flux. TINF and BINF refer to corresponding results for a cloud layer of infinite horizontal extent. Apart from these differences, Table 3.3.1 is similar in format to Table 3.2.1 and permits comparisons among the results from CTRANS, FLX, and McKee and Cox.

3.4 GROUND PLANE REFLECTIONS

The basic mechanism for handling Lambertian reflection has been tested implicitly in the Rayleigh atmosphere tests reported in Section 3.1. The capacity of CTRANS to handle inhomogeneous Lambertian ground patterns may be illustrated by a test example but specifically comparable independent calculations do not appear to be available.

As a suitable test example, the basic ground patterns were chosen as half planes of differing albedo with boundaries parallel to the y-axis and x-axis intersections at a number of points along the axis. The receiver was above the top of the atmosphere (704 km) centered at $(X_k^R, Y_k^R) = (0,0)$ and looking towards the nadir. The receiver field of view was 85.2 μrad yielding a 60 m diameter footprint on the ground. The atmosphere was composed of Rayleigh and haze C aerosol scatterers with total optical thicknesses of .098 and .19643, respectively. The wavelength employed was $\lambda = 0.55$ μm. The albedo pairs employed were (.6, 0), (.5, .1), (.4, .2), (.3, .3) with boundaries intersecting the x-axis at $X = \pm 2.0, \pm 1.0, \pm 0.5, \pm 0.25, \pm 0.05, 0.0$ km. In addition to the half-planes, results for uniform Lambertian ground planes

with albedos .6, .5, .4, .3, .2, .1, and 0.0 were obtained All results were, of course, obtained simultaneously. These results are shown in Figure 3.4.1. Since all computed values depend upon the same set of photon tracks, relative values are computed more accurately than absolute values. This feature is of great importance when CTRANS is used, for example, to determine the distinguishability of surface features as seen from a satellite.

The ground plane reflection characteristics may be modified in yet another way: the reflectance type may be changed from Lambertian to rough Fresnel, useful for sea surface modeling. Several independent calculations exist against which CTRANS' results may be validated. We chose the following parameters to specify a suitable test case: solar zenith angle, $\theta_0=57°$; wind speed=5 m/sec (yields a wave slope variance $\sigma^2=0.0286$); wavelength, $\lambda=0.70$ μm; Rayleigh optical thickness $\tau_R=.037$; aerosol optical thickness $\tau_M=0.214$; the field of view of the receiver was taken to be zero. These parameter values were chosen so as to be able to compare our results with those computed independently by RADTRAN. These model parameters are also similar to (but not identical with) those used by Kattawar and Plass.[4)] Figure 3.4.2 presents the results of CTRANS as well as those of RADTRAN and Kattawar and Plass. As may be seen, all three calculations are in agreement to within 1.4 times the computed standard error.

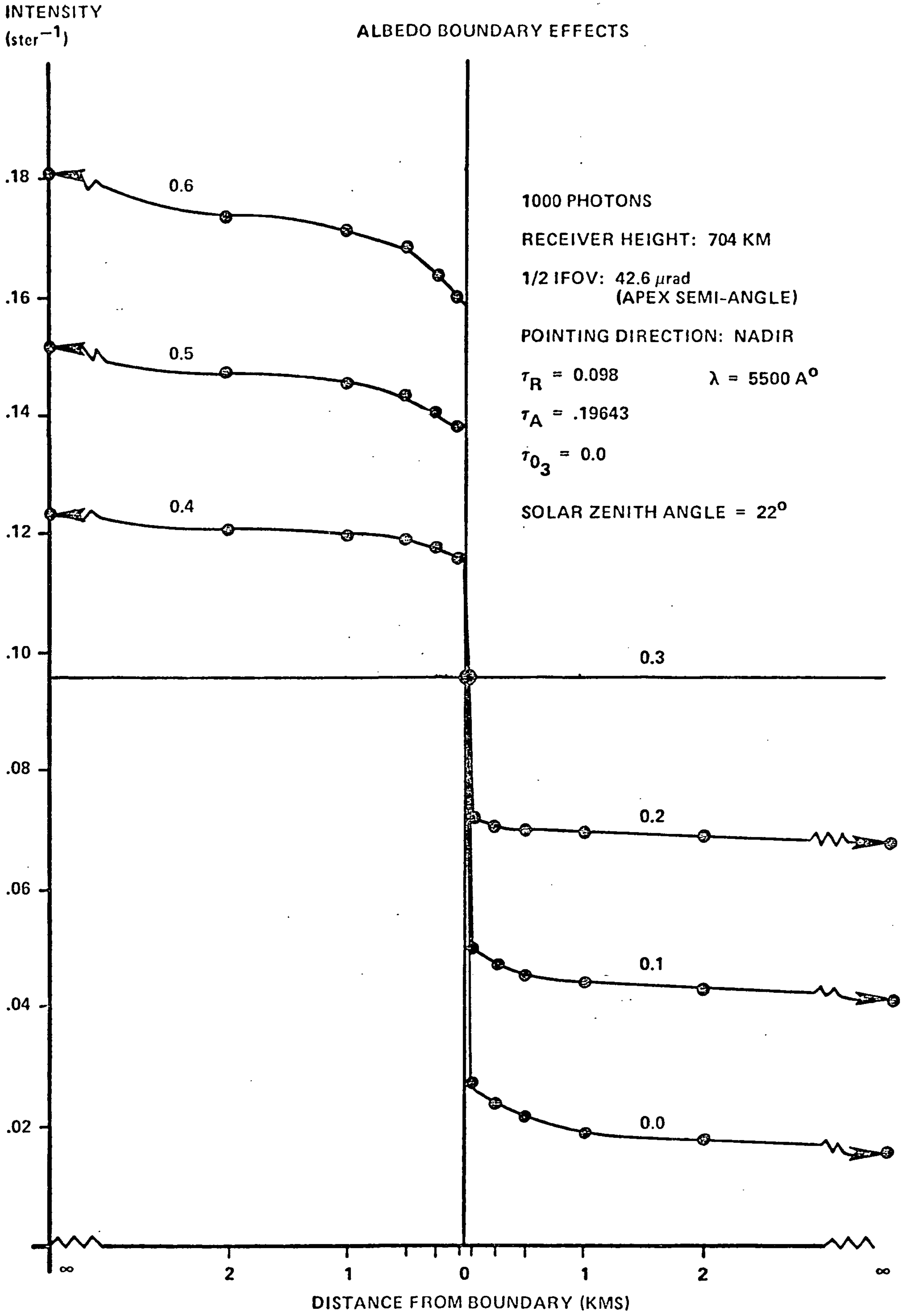
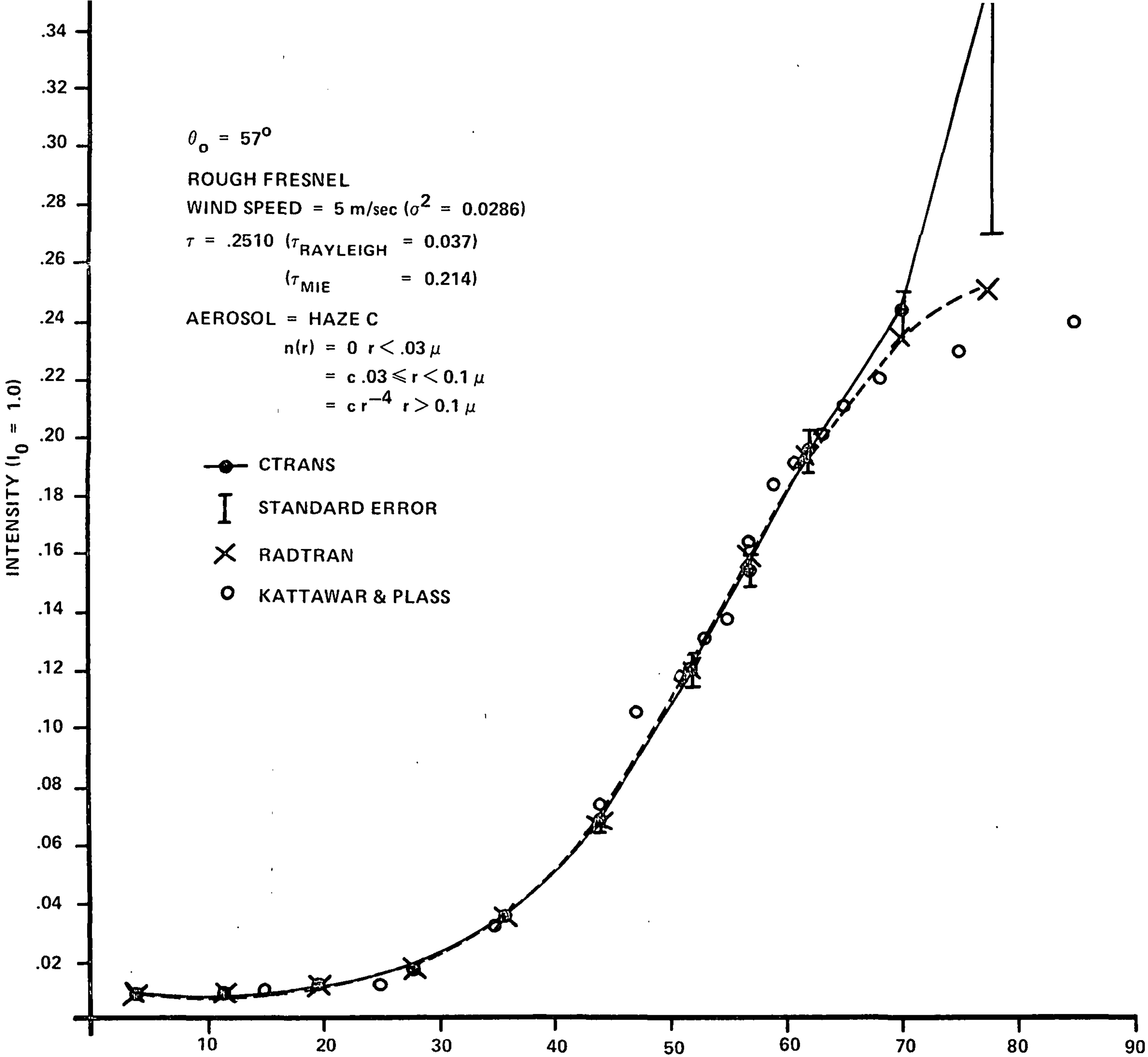

INTENSITY
(ster^{-1})
ALBEDO BOUNDARY EFFECTS
.18
.16
.14
.12
.10
.08
.06
.04
.02
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1000 PHOTONS
RECEIVER HEIGHT: 704 KM
1/2 IFOV: 42.6 μrad
(APEX SEMI-ANGLE)
POINTING DIRECTION: NADIR
τ_R = 0.098
λ = 5500 A^o
τ_A = .19643
τ_{O_3} = 0.0
SOLAR ZENITH ANGLE = 22^o
∞
2
1
0
1
2
∞
DISTANCE FROM BOUNDARY (KMS)

FIGURE 3.4.1.



θ_o = 57°
ROUGH FRESNEL
WIND SPEED = 5 m/sec (σ^2 = 0.0286)
τ = .2510 ($\tau_{RAYLEIGH}$ = 0.037)
(τ_{MIE} = 0.214)
AEROSOL = HAZE C
n(r) = 0 r < .03 μ
= c .03 ≤ r < 0.1 μ
= c r^{-4} r > 0.1 μ
CTRANS
STANDARD ERROR
RADTRAN
KATTAWAR & PLASS
INTENSITY (I_0 = 1.0)
.34
.32
.30
.28
.26
.24
.22
.20
.18
.16
.14
.12
.10
.08
.06
.04
.02
10
20
30
40
50
60
70
80
90
RECEIVER NADIR ANGLE (DEG)

FIGURE 3.4.2.

SECTION 4.0
SUBROUTINES: DESCRIPTIVE OUTLINES

In its present version, CTRANS is composed of a MAIN control routine and 34 supporting subroutines. In the following, we outline the main functions of each of these.

MAIN

MAJOR FUNCTION: Main control routine

INPUTS:
1. Initial random number
2. IND,IST,ISKY,INFLUX,WAV

OUTPUTS:
1. Contribution maps
2. Timing information, number of photons tracked

ACTIONS:
1. Set up constants, initiate random number sequence, clear storage.
2. Read major control card: IND,IST,... (STOP if IND=0)
3. Call INPUT - Input model specification, write out descriptive text
4. Loop over photon tracks
   - 4.1 Initialize photon at receiver
   - 4.2 Sample direct sun contribution (use SEESOL)
   - 4.3 Loop over allowed number of scatterings
     - 4.3.1 Determine distance to scattering, propagate photon along path (TRACK)
     - 4.3.2 Determine scattering species
     - 4.3.3 Sample hypothetical photon from each sun (SAMPLE)

4.3.4 Determine scattering angle and direction (ANGLEM and JIM; or GNDREF)

4.3.5 Update cumulative scattering matrix following a real scattering (RENEW)

4.4 Clump, collect statistical measures

4.5 Check time remaining (terminate if insufficient)

5. Write contribution maps (if finite receiver field of view)
6. Normalize samples
7. Output results (OUTPUT)
8. Output statistics (TAB)
9. Return to Step 2.

INPUT

MAJOR FUNCTION: Read in model specification parameters, compute and fill reference tables, write text describing model and input quantities.

INPUTS:
1. Atmosphere description cards
2. Sun specifications
3. Size distribution parameters
4. Phase matrix elements (cards or tape)
5. Atmospheric layer heights, temperatures
6. Atmospheric layer heights, component densities
7. Cloud input specifications (CLINP)
8. Receiver specifications
9. Ground reflectance type map specifications

OUTPUTS:
1. Main title
2. Simulation parameters
3. Receiver description
4. Solar array description
5. Ground description
    - 5.1 Reflectance type map
    - 5.2 Lambertian albedo maps
6. Atmosphere description
    - 6.1 Characteristics of each type of scatterer in entire atmosphere
    - 6.2 Phase functions
    - 6.3 Ambient atmospheric densities, cross section
    - 6.4 Average scattering angle
    - 6.5 Cloud specifications

SAMPLE

MAJOR FUNCTION: Accumulates a sample for hypothetical photons arriving from each Sun. Reads no cards. Writes no text.

ACTIONS:
1. Set up photon co-ordinates (if in a cloud) (TRANS 1)
2. Loop over Suns
   - 2.1 Compute scattering angle and/or direction for scattering into Sun
   - 2.2 Determine scattering plane, normal to scattering plane, rotation angle (FIXALL)
   - 2.3 Multiply rotation into cumulative scattering matrix (ROTATE)
   - 2.4 Obtain matrix elements for scattering other than Rayleigh (ELEMTS or GENGND)
   - 2.5 Multiply scattering matrix into cumulative scattering matrix (SCATMI, SCATRA or GENSCA)
   - 2.6 Compute optical path length to Sun (SEESOL) and, thence, the attenuation factor
   - 2.7 Fold in other applicable weights
   - 2.8 Accumulate sample into sampling matrix, VSAMP

SEESOL

MAJOR FUNCTION: Determines optical path length to the Sun. Assumes that CLCORD and COORD contain position and path direction cosines for photons in a cloud or not in a cloud, respectively.

ACTIONS:

1. Determine distance out of cloud (if in a cloud) (CLOUT)
2. Compute contribution of overlying ambient atmospheric layers
3. Compute contribution of present ambient atmospheric layer
4. Compute contribution of other clouds entered along path
   - 4.1 Check cloud spheres entered along path (CLENTR)
   - 4.2 For each sphere entered, check entries in detail; get distance to entry and distance to exit for each cloud entered (SDIST,CLOUT)
5. Compute total optical distance to Sun (along the direction indicated by COORD and/or CLCORD)

TRACK

MAJOR FUNCTIONS:

1. Determines optical path length to be traversed
2. Propagate photon along its current direction until chosen optical path length is traversed
3. Update co-ordinate systems at boundary (cloud) crossings
4. Set IOUT=1 for photons exiting top of atmosphere
5. Set ISCAT=1 for photons hitting earth, compute coordinates of impact

ACTIONS:

1. Choose optical path length to be traversed $\tau=-\ell n(P)$ (P=uniformly distributed random number)
2. Set up boundaries
   - 2.1 Boundary of present cloud (if in a cloud)
   - 2.2 If not in a cloud, boundary of any cloud along extended path - use CLENTR, TDIST-or, atmospheric boundaries if no clouds can be entered
   - 2.3 Determine type of boundary
3. Successively accumulate increments in distance traversed and traversed optical path length until either the chosen optical path is exhausted or until a boundary is encountered.
4. Boundary encounter
   - 4.1 If boundary is top of atmosphere, set IOUT=1, exit
   - 4.2 If boundary is ground, set ISCAT=1, compute coordinates of impact, CG.
   - 4.3 If boundary is a cloud boundary, update coordinates and resume tracking
5. Update photon position

TRANS
TRANS1
TRANS2

FUNCTIONS: These closely related and similar routines transform coordinate positions and/or photon flight direction cosines into and out of the cloud coordinate systems.

If XC_i = photon position coordinate in the cloud $i=1,3$

X_i = photon position in fixed coordinate system $i=1,3$

XC_i = photon flight direction cosines in the cloud $i=4,6$

X_i = photon flight direction cosines in the fixed coordinate system $i=4,6$

and XCL_i = C.M coordinates of the cloud in the the fixed system $i=1,3$

θ = orientation angle of the cloud

$$\underline{XC} = \underline{\underline{R}}(\underline{X}-\underline{XCL}) \qquad i=1,3$$

$$XC = \underline{\underline{R}}(\underline{X}) \qquad i=4,6$$

$$\underline{X} = \underline{XCL} + \tilde{R}\ \underline{XC} \qquad i=1,3$$

$$\underline{X} = \tilde{R}\ \underline{XC} \qquad i=4,6$$

$$R = \begin{pmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$\tilde{R}$ = transpose of R

CLOUT(I,NOUT,CDIST,EXT)

FUNCTION: Determines the point of exit from a cloud and the distance along the photon path to this point

PARAMETERS:
I = Cloud index
NOUT = 1 if exit point is found
CDIST(I)= distance to exit point
EXT(I,J),J=1,2,3 = exit point coordinates for cloud I

METHOD:
Let C_i, C_j, C_k = exit coordinates in cloud system
X_i, X_j, X_k = present photon coordinates in cloud system
V_i, V_j, V_k = direction cosines of photon flight path in cloud system
A_i, A_j, A_k = cloud half edge lengths
all where i,J,K may be a permutation of X,Y,Z.

1. $C_i = |V_i|*A_i$

$C_j = X_j+(C_i-X_i)V_j/V_i$

$C_k = X_k+(C_i-X_i)V_k/V_i$

if C_j and C_k are within the cloud boundariesthen the exit point is (C_i, C_j, C_k) i if not, cycle through values of (i,j,k)

2. Compute distance to exit point

CLINP

FUNCTIONS: Reads in cloud input parameters, transforms these and computes auxilliary descriptive parameters.

ACTIONS:

1. Read number of clouds NCLOUD
2. Return if NCLOUD=0
3. For each cloud read
   HC,AC,BL,CC,XCL,YCL,THETAC,INC,CLDEN
   where
   HC=Altitude of base of Cloud (in km.)
   AC,BC,CC=Linear dimension of cloud (km.)
   XCL,YCL =X,Y coordinates of center of mass of the cloud in the fixed coordinate system
   THETAC =Orientation angle of the cloud measured clockwise looking up (in degrees)
   INC =Indicator of scatterer type composing cloud
   CLDEN =Density of scatterers of type INC (cm^{-3}).
4. Computes sines and cosines of THETAC, cloud edge half-lengths, radii of cloud circumscribing spheres and puts all information into the descriptive vector CLOUD(10,10):

CLOUD(I,J)	:	I=Cloud pointer
J=1,2,3	:	C.M. coordinates of the cloud
J=4,5,6	:	Half dimensions of each side of the cloud
J=7,8	:	cos (THETAC) , sin (THETAC)
J=9	:	Radius, R, of the circumscribing sphere
J=10	:	R^2

CLENTR

FUNCTIONS: Checks whether the photon can penetrate any of the cloud circumscribing spheres and orders the sequence of entry.

ACTIONS:

1. Computes square of distance to a cloud, length between point of closest approach and present photon position, and square of distance of closest approach along the extended path.

2. Orders entries by entry sequence

SDIST

FUNCTIONS: Tests which plane of the cloud photon entered, calculates distance to intersection, and orders them by entry sequence

ACTIONS:

1. For each uneliminated cloud computes point of entry and distance to that point (PLANE)
2. Orders by entry sequence (length from present position to entry point.

TDIST

FUNCTION: Calculates distance to the cloud photon can enter in TRACK

ACTION: Uses PLANE to compute distance to the first cloud entry

PLANE(I,INDC,ENT,NPLANE,DIST)

FUNCTION: Calculates the coordinates of the point of entry of a photon into a cloud and determines the distance to this point from the photon's present position

PARAMETERS:
- I = Cloud index
- INDC = Parameter controlling the transformation into/out of cloud coordinate system
- ENT(I,J) J=1,2,3 = Coordinates of point of entry into cloud I
- NPLANE = 1 if entry can occur
  = 0 otherwise
- DIST(I) = Distance to point of entry into cloud I

METHOD: Let C_i, C_j, C_k = Entry coordinates in cloud system

X_i, X_j, X_k = Present photon position coordinates in cloud system

V_i, V_j, V_k = Direction cosines of photon flight path in cloud system

A_i, A_j, A_k = Cloud half-edge lengths all where i,j,k are a permutation of X,Y,Z.

1. If $|X_i| \leq A_i$ try another permutation
2. If $X_i < A_i$ $C_i = -A_i$

   $X_i > A_i$ $C_i = A_i$
3. If $(X_i - C_i)A_i > 0$ or $V_i = 0$. Try another permutation
4. $C_j = X_j + (V_j/V_i)\ (C_i - X_i)$

   $C_k = X_k + (V_k/V_i)\ (C_i - X_i)$

5. If C_j and C_k lie within the cloud boundaries, exit point is (C_1,C_2,C_3)
If not, try another permutation

6. Calculate distance to entry point, set NPLANE=1

7. If no entry point has been found after three permutations, set NPLANE=0

FIXALL (UX,UY,UZ,CX,CY,CZ,UN,VN,WN,ANGLE,A,B,C,)

FUNCTIONS:	Determines normal to the scattering plane and the angle through which the Stokes vector must be rotated		
PARAMETERS:	$\underline{U}$ = UX,UY,UZ	Direction cosines of post-scattering photon	
	$\underline{C}$ = CX,CY,CZ	Direction cosines of pre-scattering photon	
	$\underline{N}$ = UN,VN,WN	Direction cosines of normal to previous scattering plane	
	ANGLE	Necessary angle of rotation	
	$\underline{M}$ = A,B,C	Direction cosines of normal to new scattering plane	

ACTIONS:

1. Checks (UX,UY,UZ) and CX,CY,CZ) for parallelism if parallel, return with (A,B,C)=(UN,VN,WN),ANGLE=0.
2. Computes direction cosines of normal to scattering plane, (A,B,C) via NORMAL
3. Computes dot product $\underline{N}\cdot\underline{M}$ and thence the rotation angle magnitude
4. Sets ANGLE=-ANGLE IF C•(MxN)<0.

NORMAL (CX1,CY1,CZ1,CX2,CY2,CZ2,CX,CY,CZ)

FUNCTION: Computes direction cosines of unit vector normal to the plane defined by two vectors

PARAMETERS:

$\underline{V1}$	= (CX1,CY1,CZ1)	Direction cosines of one vector defining plane
$\underline{V2}$	= (CX2,CY2,CZ2)	Direction cosines of other vector defining planes
$\underline{N}$	= (CX,CY,CZ)	Direction cosines of NORMAL

ACTION:

1. Computes N = $\underline{V1} \times \underline{V2}$
2. Normalizes N to unit magnitude

i.e. $$N = \frac{\underline{V1} \times \underline{V2}}{|\underline{V1} \times \underline{V2}|}$$

JIM (COUT,CIN,CP,SP,CB,SB)

FUNCTION:	Computes photon direction cosines after scattering given the direction cosines prior to scattering and the polar and azimuthal scattering angles		
PARAMETERS:	COUT(J)	J=1,3	Photon position coordinates
		J=4,6	Post-scattering direction cosines
	CIN(J)	J=1,3	Photon position coordinates
		J=4,6	Pre-scattering direction cosines
	CP,SP	Cosine and sine of azimuthal scattering angle	
	CB,SB	Cosine and sin of polar scattering angle	

ACTION: Let θ,ϕ = polar coordinates of CIN(J), J=4,6 then

COUT(4) = CB*CIN(4)-SB*SP*SIN(ϕ)+SB*CP*CIN(6)*COS(ϕ)

COUT(5) = CB*CIN(5)+SB*SP*COS(ϕ)+SB*CP*CIN(6)*SIN(ϕ)

COUT(6) = CB*CIN(6)-SB*CP*SIN(θ)

XSECTM

XS2

FUNCTION: These essentially similar routines perform table look-up and interpolation of the phase function given a value for the scattering angle, B. XSECTM operates only on S_{11} and XS2 operates on general phase matrix elements.

METHOD: Three point Newton's method - see for example R.W. Hamming, <u>Numerical Methods for Scientists and Engineers</u>, McGraw-Hill, New York, 1962; p 99.

ANGLEM

FUNCTION: Given a rectangularly distributed random number, and the scattering species index, chooses a scattering angle by table look-up. Uses the scattering angle distribution function formed from S_{11} for the indicated species.

PARAMETERS: Where JK points to the scattering species

X1(JK,100) = Table of scattering angles for species JK

Y1(JK,100) = Probability distribution function for the angles listed by X1 computed from S_{11}.

METHOD: 2 or 3-point Newton's method

ELEMTS (BETA,S,K)

FUNCTION: Computes all the scattering matrix elements (for an atmospheric scattering) for a specified scattering angle BETA.

PARAMETERS: BETA = Scattering angle

$S(I)$ = Result value of I^{th} matrix element

$S(1) = S_{11}$

$S(2) = S_{12}$

$S(3) = S_{33}$

$S(4) = S_{34}$

$S(5) = S_{22}$

$S(6) = S_{44}$

ACTIONS: Use XSECTM to obtain S(1) for hypothetical scattering (S(1)=1 for real scattering).

Use XS2 for remaining matrix elements.

RENEW (COUT,BETA,CB)

FUNCTION: Updates the cumulative scattering matrix following a real scattering

PARAMETERS: COUT = Six-vector describing post-scattering photon

BETA = Scattering angle

CB = cos(BETA)

ACTIONS:

1. Determine normal to new scattering plane and the angle between it and the normal to the previous scattering plane (or reference direction) using FIXALL

   1.1 Update scattering plane normal

2. Post-multiply a rotation into the cumulative scattering matrix

3. Obtain scattering matrix elements and accumulate a scattering by post-multiplication

   3.1 For ground scattering obtain matrix elements from LAMBRT (Lambertian scattering) or from GENGND (rough Fresnel scattering) and use GENSCA to accumulate the scattering.

   3.2 For atmospheric scattering, obtain Mie or generalized scattering matrix elements from ELEMTS. Accumulate the scattering using SCATRA (Rayleigh scattering-matrix elements computed), GENSCA (general scattering), or SCATMI (Mie scattering).

4. Update CIN to the values contained in COUT.

FUNCT (A1,B1,C1,D1,IDIST,D)

FUNCTION: Computes the value of the particle diameter probability density function for a given particle diameter.

PARAMETERS:

A1,B1,C1	=	distribution function parameters	
D1	=	Normalization factor	
IDIST		Specifies type of distribution	
	=	1	Junge
	=	2	Deirmendjian
	=	3	Log-normal
	=	4	Haze-C (Junge with pedestal)
D	=	Particle diameter	

USE: FUNCT is called as a function

ACTIONS:

IDIST=1 FUNCT $= D1*D^{-B1} \qquad D \geq A1$

$= 0. \qquad D < A1$

IDIST=2 FUNCT $= D1*D^{A1} \; \exp\left(-B1*D^{C1}\right)$

IDIST=3 FUNCT $= 0. \qquad D \leq C1$

$$= \frac{D1}{D-C1} \exp\left\{-\left[A1*\ln\left(\frac{D-C1}{B1-C1}\right)\right]^2\right\}$$

IDIST=4 FUNCT $= 0 \qquad D < C1$

$= D1 \qquad C1 \leq D < A1$

$= D1\left(\frac{A1}{D}\right)^{B1} \qquad D \geq A1$

GENSCA (SSIN,SOUT,SK,K)
SCATMI (SSIN,SOUT,S,K)
SCATRA (SSIN,SOUT,CB,K)

FUNCTIONS: These similar routines accumulate a new scattering by post-multiplying the scattering phase matrix into the cumulative scattering matrix for real or hypothetical (sampling) scattering.

PARAMETERS:

SSIN = 16-element vector containing the elements of the 4x4 cumulative scattering matrix arrayed column-wise.

SOUT = 16-element vector of elements of cumulative scattering matrix after scattering.

S = 6-element vector of matrix element values

K = 1 Compute only first column of SOUT (i.e., first 4 elements) for hypothetical (sampling) scattering. All elements are not needed for unpolarized incident light.

K = 2 Compute all elements of SOUT.

CB = Cosine of scattering angle used by SCATRA to compute scattering matrix elements.

ACTIONS: If $\underline{\underline{S_o}}$, is the output matrix, $\underline{\underline{S_I}}$ is the input matrix

$$\underline{\underline{S_o}} = \underline{\underline{S_I}} \times \begin{pmatrix} S_{11} & S_{12} & 0 & 0 \\ S_{12} & S_{22} & 0 & 0 \\ 0 & 0 & S_{33} & S_{34} \\ 0 & 0 & -S_{34} & S_{44} \end{pmatrix}$$

SPECIALIZATION: SCATMI Assumes that $S_{33}=S_{44}$ and $S_{11}=S_{22}$

Assumes that $S_{11}=1$ if K=2

SCATRA Computes $S_{11}=\frac{3}{4}\ (1+(CB)^2)=S_{22}$

$S_{12}=\frac{3}{4}\ ((CB)^2-1)$

$S_{33}=\frac{3}{2}\ CB=S_{44}$

$S_{34}=0.$

Takes $S_{11}=1$ and normalizes other matrix elements by dividing by $\frac{3}{4}(1+(CB)^2)$ if K=2.

ROTATE (SSIN,SOUT,PHI)

FUNCTION: Folds a rotation into the cumulative scattering matrix by post-multiplication.

PARAMETERS: SSIN = 16-element vector containing column-wise ordered elements of the cumulative scattering matrix

SOUT = 16-element vector containing elements of the cumulative scattering matrix after rotation.

PHI = Rotation angle

ACTIONS: $\underline{\underline{S_o}}$ is the cumulative scattering matrix after rotation

$\underline{\underline{S_I}}$ is the cumulative scattering matrix before rotation

ϕ = rotation angle

$$\underline{\underline{S_o}} = \underline{\underline{S_I}} \times \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 2\phi & \sin 2\phi & 0 \\ 0 & -\sin 2\phi & \cos 2\phi & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

REFLOC (CG,IRCOD)

FUNCTION:	Returns a value of IRCOD indicating the reflectance type at a point indicated by CG corresponding to the map choice fixed by INPUT.	
PARAMETERS:	CG(1),CG(2)	= X-Y location of point of impact of photon on the ground
	IRCOD	= Reflectance type code
		= 0 Lambertian
		= 1 Rough Fresnel

ACTIONS:

1. If ground is uniform plane (i.e., IRPAT=0) IRCOD=IRBGD
2. If map is half-planes |IRPAT|=1 then
   for IRPAT=+1 and X>XBND IRCOD=IRSPOT
   for IRPAT=-1 and X<XBND IRCOD=IRSPOT
   with
   IRCOD=IRBGD otherwise
3. If map consists of rectangles differing from background (IRPAT=2) then
   IRCOD=IRSPOT if $|X-CNTRX| \leq EDGEX/2$ and $|Y-CNTRY| \leq EDGEY/2$
   IRCOD=IRBGD otherwise

LAMBRT (COUT,S,K)

FUNCTION: Constructs matrix elements appropriate to Lambertian scattering

PARAMETERS: COUT = Descriptor vector for scattered photon COUT(6)=zenith cosine

S = 6-vector of matrix elements

K = 1 Indicates hypothetical scattering

K = 2 Indicates real scattering

ACTIONS: S(1) = 2*COUT(6) K=2

S(1) = 4*COUT(6) K=1

S(J) = 0 J=2,6

GNDREF (COUT,CIN,XTH,XPH,IRCOD)

FUNCTION: Generates a reflection direction from the ground

PARAMETERS:
COUT = Post-scattering photon descriptor
CIN = Pre-scattering photon descriptor
XTH,XPH = Uniformly distributed random numbers
IRCOD = Reflectance type indicator
= 0 Lambertian
= 1 Rough Fresnel

ACTIONS:

1. For Lambertian reflection
   $\phi = 2\pi$*XPH
   $\text{Cos}(\theta) = \text{XTH}$
   COUT(4) = $\text{SIN}\theta\ \text{COS}\phi$
   COUT(5) = $\text{SIN}\theta\ \text{SIN}\phi$
   COUT(6) = $\text{COS}\theta$
   COUT(J) = CIN(J), J=1,3

2. For rough Fresnel reflection
   2.1 Find slope X,Y components from Gaussian distribution through GAUSS (standard deviation=WSIG, mean=0.)
   2.2 Compute normal to slope (direction cosines labeled WNG(I), I=1,3)
   2.3 Check to see if slope is visible to incident photon (visible if
   $$G = \sum_{J=1}^{3} \text{CIN}(J)*\text{WNG}(J) \leq 0.)$$
   2.4 COUT(J+3) = -2G*WNG(J)+CIN(J+3) forms the direction cosine of reflection direction

GENGND (COUT,CIN,IRCOD,S,K)

FUNCTION: Computes Fresnel matrix elements multiplied by statistical factors

PARAMETERS:

COUT,CIN	=	Scattered and unscattered photon descriptors, respectively
IRCOD	=	Not used
S	=	6-vector of matrix elements
K	=	1 Hypothetical (sampling) scattering
	=	2 Real scattering

ACTIONS: Let $\underline{V}_o$ and $\underline{V}_i$ be the (unit) photon propagation vectors following and prior to reflection, respectively and $\underline{n}$ be the normal to the surface facet.

1. Compute cosine of angle of incidence:

$$\cos X = \sqrt{\frac{1 - \underline{V}_o \cdot \underline{V}_1}{2}}$$

2. Compute factor to account for non-vertical incidence of photon (modification to probability of encounter for a chosen facet slope)

$$FACTR = \cos X / [(\hat{n} \cdot \hat{Z}) \ (-\hat{Z} \cdot V_I)]$$

3. Compute cosine of angle of refraction

$$\cos \theta_t = \sqrt{1 - \frac{1}{f^2} (1 - \cos^2 X)} \quad f = \text{Index of refraction}$$

4. Compute Fresnel factors

$$R_{11} = \frac{f \cos X - \cos\theta_t}{f \cos X + \cos\theta_t} \ ; \ R_1 = \frac{\cos X - f \cos\theta_t}{\cos X + f \cos\theta_t}$$

5. Compute matrix elements

$$S_{11} = (R_{11}^2 + R_1^2)/2 = S_{22}$$

$$S_{12} = (R_{11}^2 - R_1^2)/2$$

$$S_{33} = S_{44} = R_1 R_{11}$$

$$S_{34} = 0$$

6. If K=1, compute probability of encountering proper slope; FEXP

7. Fold all auxilliary factors into matrix elements.

TAB (VSAMP2,VSAMP3,XMC,XMX,IND,IFL)

FUNCTION: Compute and display mean, variance, standard deviation, and standard error for each sun, each Lambertian albedo pattern, and each Stokes' parameter (I,Q,U,V) for single scattering, multiple scattering and total. Compute correlation coefficients amongst suns.

PARAMETERS:

VSAMP2 = Sample matrix VSAMP2(IQUV,ISUN,IS,1,IALB) where

- IQUV Points to Stokes' parameters
- ISUN Designates the sun
- IS Designates direct sun contribution, single scattering, and higher order scattering.

VSAMP3 = Sample matrix of squares of clumps

XMC = Number of clumps

XMX = Factor used to normalize results to the number of photons actually tracked (when this varies from NMAX).

IND = 5 or 6 display results only for zero albedo

IFL = Indicator designating whether answers are for flux or intensity

ACTIONS:

1. Compute normalization factors f=(solar const.)/4π)
2. Compute and write means and standard deviations

   $$\text{std. dev.} = \sqrt{\frac{XMC}{XMC-1}\ [VSAMP3*f^2*XMC-(MEAN)^2]}$$

3. Compute variance = (std. dev.)^2 = σ^2

   and standard error = $\sqrt{\sigma^2/XMC}$

4. Compute correlation coefficient matrix for results for each solar direction.

OUTPUT (VSAMP,IND,FACT)

FUNCTION: Normalize results, write out intensity or flux results labeled by Lambertian albedo pattern. If appropriate, compute effective albedo evaluated from regression on uniform albedo patterns and modulation transfer functions.

PARAMETERS: VSAMP = Sample matrix
IND = Not used
FACT = Normalization adjustment factor (normally FACT=.25)

ACTIONS:

1. Compute normalization factor f=(solar const.)*FACT/π. If receiver is the face of a cloud, normalize to unit flux incident on the cloud (Cox-McKee normalization).

2. Write out results (normalized) for intensity or flux. For intensity, results are direct sun contribution, single scattering, higher order scattering, and total intensity. For flux, results are direct solar contribution, upward flux, downward flux, total flux.
3. If the Lambertian albedo patterns contain uniform planes with A=0. and at least two others (and if the reflectance type map is uniformly Lambertian) perform a regression analysis: find AL,BL in the expression

$$[I(A)-I(0)]/A = AL + BL*[I(A)-I(0)]$$

where A refers to the albedo and I(A) is the result for albedo=A. Use AREG. Also computed are the effective albedos for other albedo patterns.

4. If appropriate (IMTF=1, set by ALBEDO) compute percent contrast from pairs of results both for intensity and effective albedo.

ALBEDO (IALB,ALBPT)

FUNCTION: Write titles or compute the albedo at the point specified by CG.

ACTIONS:

1. IALB = -J Write out description (50 character maximum width) of albedo pattern J.

   IALB = +J Compute albedo at the point X=CG(1), Y=CG(2) and return this value as ALBPT.

2. If this pattern is for computing MTF's, set IMTF=1.

AREG (NALB,AL,BL)

FUNCTION: Perform albedo regression analysis assuming FTOT (NALB) is the value corresponding to a uniform zero albedo plane.

PARAMETERS:

NALB = Total number of albedo patterns

NUNIF = Number of uniform plane albedo patterns

AL,BL = Regression coefficients

ACTIONS:

1. Use LINFIT to compute albedo regression coefficients AL,BL

   Regression Form: [I(A)-I(A=0.)]/A=AL+BL*[I(A)-I(A=0.)]

2. Compute effective albedo (AEFF(I), I=1,NALB-1):

$$\text{AEFF(I)} = \frac{\text{I(J)-I(NALB)}}{\text{AL+BL*(I(J)-I(NALB))}}$$

   AEFF(NALB) = 0.

LINFIT (N,Y,X,A,B)

FUNCTION: Performs linear regression, finding the parameters A,B which best fit the form Y=A+B*X where Y(N),X(N) are vectors of length N.

METHOD:

$$B = \frac{N \sum_{i=1}^{N} X_i Y_I - \sum_{i-1}^{N} X_i \sum_{i=1}^{N} Y_i}{N \sum_{i=1}^{N} X_i^2 - \left(\sum_{i=1}^{N} X_i\right)^2}$$

$$A = \frac{1}{N}\left(\sum_{i=1}^{N} Y_i - B \sum_{i=1}^{N} X_i\right)$$

SECTION 5.0
INPUT PARAMETERS

The input parameters are listed below, together with a concise description of their use, meaning, and default values (if applicable). The order of appearance is that of a proper data deck.

Initial random number (may be blank, default value = 65549)
    (I7)
IND,IST,ISKY,INFLUX,WAV
    (4I1,F8.5)

IND = Calculation extent indicator
- = 0 Stop calculation
- = 2 Input new clouds and receivers only
- = 4 Normal start
- = 5 Omit polarization, set scattering matrix $S_{ij}=0$ for $i,j\neq 1$
- = 6 Calculate only for completely absorbing ground
- = 7 Completely absorbing ground + no polarization

IST = New atmosphere indicator
- = 1 Read in new atmosphere
- = 0 Use one already read in

ISKY = Sun indicator
- = 0 User specified suns (maximum of 5)
- = 1 Suns at $\theta=0°,30°,60°;\phi=0$
- = 2 Suns at $\theta=0°,30°,60°;\phi=\pi/4$
- = 3 Suns at $\theta=0°,30°,60°;\phi=\pi/2$

INFLUX = Indicator specifying whether flux or intensity is to be calculated.
- = 0 Calculate flux at receiver
- = 1 Calculate intensity at receiver

WAV = Wavelength of radiation (in micrometers).

INDIC(5),IDIST(5),NLAYER,NSOL,NMAX,NSCA,NALB,IUNIT(5),NTOT(5)
(10I1,2I3,I6,7I2,5I3)

INDIC(k) = Indicator for type of k^{th} species.
- $\geq$ 5 If species is not present
- = 0 For Rayleigh (matrix elements computed)
- = 1 For monodisperse Mie (matrix elements read from binary tape)
- = 2 For polydisperse Mie (matrix elements computed while reading from binary tape)
- = 3 For experimental data (matrix elements read from cards)
- = 4 For ozone (absorption only)

IDIST(k) = Particle diameter distribution indicator for k^{th} species.
- = 1 For Junge distribution
- = 2 For Deirmendjian's Haze model
- = 3 For log-normal distribution
- = 4 For Haze C (Junge with pedestal)

NLAYER = Number of plane parallel layers in ambient atmosphere.

NSOL = Number of solar zenith angles to be considered.

NMAX = Number of photons to be tracked

NSCA = Maximum number of scatterings allowed per photon track

NALB = Number of Lambertian albedo maps

IUNIT(k) = Indicator of (tape) unit from which matrix elements of k^{th} species is to be read.

NTOT(k) = Number of diameter steps to be read for the k^{th} (polydisperse) scattering species.

INDICA(5)

(5I1)

INDICA(k) = Indicator similar to INDIC(k) but applicable to ambient atmosphere (not clouds).

Note - Any species appearing in INDICA must also appear in INDIC.

SCALE(5)

(5E11.6)

SCALE(k) = 0. Use cross section as otherwise read in and/or computed for species k.

>0. Scale cross section of ambient atmosphere component k so that the total vertical optical thickness of component k=SCALE(k).

AR,BR

(2F8.6) AR and BR specify the Rayleigh cross section σ_R:

$\sigma_R = AR x 10^{-28} x \lambda^{-BR}$, where λ is the wavelength.

ADEF,EXPFAC

(2F8.5)

ADEF = Ozone cross section

$\sigma_{O_3} = ADEF/2.687 x 10^{19}$

EXPFAC = Scale height adjustment parameter for molecular species. If H is the effective scale height computed from densities as read from cards, the adjusted scale height H'=H/(1-H*EXPFAC).

INDOZ,INDCOZ

(2I1)

INDOZ = Ozone input units specification

= 0 Ozone densities cm^{-3} are read in

≠ 0 Ozone partial pressures are read in

= 1 Ozone densities computed from partial pressures are temperature corrected.

INDCOZ Inactive parameter, no function ascribed for it in this version.

SOLC

(F10.6)

SOLC = Solar constant assumed for normalization

= 0. (or blank) on input, a value of 1.0 is adopted.

≠ 0. Use the specified value of SOLC.

If ISKY=0, solar directions must be read in as follows:

THETA(1),PHI(1)

(F7.4,F7.2)

⋮

THETA(NSOL),PHI(NSOL)

THETA(I) = Solar zenith angle for I^{th} sun (in degrees)

PHI(I) = Solar azimuth from I^{th} sun (in degrees)

NK(1),STEP(1),A1(1),B1(1),C1(1),ITAPE(1)

(I3,4F8.3,I1)

⋮

[When the K^{th} species' matrix elements are to be read from cards, they appear as follows:]

```
NK(K),STEP(K),...
CSECT(K),ASECT(K)
   (2E11.4)
XA,S11(1,K),S12(1,K),S22(1,K),S33(1,K),S34(1,K),S44(1,K)
   (F6.1,6E12.5)
XA,S11(NK,K),S12(NK,K),...
:
NK(KMAX),STEP(KMAX),A1(KMAX),...(Where KMAX is the maximum
                                 total number of atmospheric
                                 species present)
```

NK(K) = Number of angles for which the matrix elements of the K^{th} species are to be read from tape or cards.

STEP(K) = Step size in x ($x=\pi D/\lambda$) for polydispersions (K^{th} species)

= Value of x for monodispersions (K^{th} species)

A1(J),B1(J),C1(J) are the parameters entering into the particle size distribution function for the J^{th} scatterer type.

For IDIST(J) = 1, the diameter distribution is

$$F = D1\ D^{-B1} \qquad D \geq A1$$

where $D1=(B1-1)\ A1^{(B1-1)}$

For IDIST(J)=2

$$F = D1\ D^{A1} \exp(-BB1*D^{C1})$$

$$\text{where } D1 = \frac{C1\ \ B1^{(A1+1)/C1}}{(2^{A1+1})\Gamma(\frac{A1+1}{C1})}$$

$$BB1 = B1*2^{-C1}$$

For IDIST(J)=3

$$F = \frac{D1}{D-C1} \exp\{-[A1 \log (\frac{D-C1}{B1-C1})]^2\}, \quad D>C1$$

$$= 0. \quad D \leq C1$$

where $D1 = A1/\sqrt{\pi}$

For IDIST(J)=4

$$F = 0. \qquad D<C1$$

$$F = D1 \qquad C1 \leq D < A1$$

$$F = D1 \left(\frac{A1}{D}\right)^{B1} \qquad A1 \leq D$$

where $D1 = \frac{B1-1}{(B1-1)(A1-C1)+A1}$

ITAPE(J) = 0 Use NTOT(J) and STEP(J) as read from cards.
= 1 Read NTOT(J) and STEP(J) from Mie tape.

XH(1),TEMP(1)
(F3.0,2X,F3.0)

⋮

XH(NLAYER),TEMP(NLAYER)
XH(J) = Layer top height of J^{th} ambient atmospheric layer (in km.)
TEMP(J) = Temperature of J^{th} layer (in °K)

XH(1),DENS(1,1)
(F3.0,2X,E9.3)

⋮

XH(NLAYER),DENS(1,NLAYER)

XH(1),DENS(2,1)

⋮

XH(NLAYER),DENS(KMAX,NLAYER)

XH(J) = Layer top height of J^{th} ambient atmospheric layer (in km.)

DENS(K,J) = Density of K^{th} species in J^{th} layer (cm^{-3})

NCLOUD

(I3)

NCLOUD = Number of clouds to be considered.

*** The following are read in if NCLOUD>0

HC(1),AC(1),BC(1),CC(1),XCL(1),YCL(1),THETAC(1),INC(1),CLDEN(1)

(F8.5,5F8.3,F8.5,I3,E9.3)

⋮

HC(NCLOUD),AC(NCLOUD),...

HC(I) = Altitude of bottom surface of I^{th} cloud (in km.)

AC(I),BC(I),CC(I) = Edge lengths of I^{th} cloud (in km.)

THETAC(I) = Angle between the x-axis of the cloud and that of the general co-ordinate system (measured clockwise in degrees looking up from the ground).

INC(J) = Indicator of the atmospheric constituent appropriate to I^{th} cloud [e.g.,INC(1)=3 states that cloud number 1 is composed of the species specified by INDIC(3)].

CLDEN(I) = Density of cloud-specific scatters of the type labeled by INC(I) (in cm^{-3}).

IRCLD,IREC,RECANG,HR,CZO,RPHI,RX,RY,SZO,IAPAT,NCON

(2I2,7E10.4,2I2)

IRCLD	= Receiver extent indicator	
	= 0 Receiver with infinitesimal area	
	= J>0 Receiver extends over an entire face of cloud J.	
IREC	Specifies which face of the cloud is to be the receiver.	
	= 1 + X Face of cloud IRCLD	
	= 2 - X Face of cloud IRCLD	
	= 3 + Y Face of the cloud IRCLD	
	= 4 - Y Face of cloud IRCLD	
	= 5 + Z Face of cloud IRCLD	
	= 6 - Z Face of Cloud IRCLD	
	< 0 Receiver points out of cloud IRCLD. |IREC| specifies which face as above.	
RECANG	= Apex angle of cone of receiver field of view in milliradians.	
HR	= Height of receiver (ignored if receiver is a cloud face)	
CZO	= Zenith cosine of receiver pointing direction (ignored if receiver is a cloud face)	
RPHI	= Azimuthal angle of plane containing receiver field of view and the vertical (ignored if receiver is a cloud face)	
RX,RY	= X,Y co-ordinates of receiver (ignored if receiver is a cloud face)	
SZO	= Sine of receiver zenith angle	
	= 0. or blank - SZO is computed from CZO	
	≠ 0. CZO,, computed from SZO (ignored if receiver is a cloud face)	
IAPAT	= Index of albedo pattern for which the intensity is to be mapped within the receiver field of view.	
	DEFAULT VALUE-IAPAT=1	(Max=50)
NCON	= Number of THETA BINS=Number of PHI bins for mapping of response within the receiver field of view.	
	DEFAULT=20	(Max=20)

IRPAT,IRBGD,XBND,FN,WSPD,WC0,WC1,WSIG2
(2I2,6E11.4)

IRPAT = Specification of reflectance type map
= 0 Uniform plane (= Background)
=+1 Plane differs from background for X>XBND
=-1 Plane differs from background for X<XBND
= 2 Inhomogeneties are rectangles set upon uniform background plane.

IRBGD = Specification of character of background
= 0 Background is Lambertian
= 1 Background is rough Fresnel

XBND = Boundary line for half-plane pattern
= X-co-ordinate of line parallel to Y-axis

FN = Index of refraction for Fresnel reflectance
DEFAULT=1.338

WSPD = Wind speed (m/sec.) for rough Fresnel

WC0,WC1 = Parameters used to construct variance, WSIG2
If both = 0 (or Blank), use default values:
WC0= .0015
WC1=2.54E-03

WSIG2 = Variance for Gaussian slope distribution for rough Fresnel reflectance
Non-zero or non-blank entry takes precedence over value computed from WC0,WC1, and WSPD.

If IRPAT=2, the following cards are required.

NSPOT
(I2)

NSPOT = Number of non-overlapping rectangular inhomogeneities (maximum NSPOT=20)

CNTRX(1),CNTRY(1),EDGEX(1),EDGEY(1)
(4E11.4)

⋮

CNTRX(NSPOT),CNTRY(NSPOT),...

CNTRX(J),CNTRY(J) = X-Y co-ordinates of rectangle J
EDGEX(J),EDGEY(J) = X,Y edge lengths of rectangle J

MIE TAPE FORMATS

MONODISPERSE

$$I=1,n \begin{cases} \text{REFACT,ALPHA,QSCA,COSBAR,QEXT} \\ J=1,NK(K)\{XA,AA1,AA2,S33(J,K,1),S34(J,K,1),S11(J,K),S12(J,K,1) \end{cases}$$

where

n is computed from A1(K) and STEP(K) read in on cards:

n = INT(A1(K) (STEP(K)+.5)

REFACT = complex index of refraction

ALPHA = size parameter $\alpha = \pi d/\lambda$, d = diameter, λ = wavelength

QSCA = scattering cross section normalized by geometric cross section

QEXT = extinction cross section normalized by geometric cross section

$$\text{eg } \sigma_{SCA}(cm^2) = Q_{SCA} \times \pi \frac{d^2}{4} \times 10^{-8}$$

with d in micrometers

COSBAR - not used

NK(K) = number of scattering angles for species k

XA = scattering angle (degrees)

C-2

$$\left.\begin{array}{l} S33 \\ S11 \\ S12 \end{array}\right\}$$ Scattering matrix elements for Jth scattering angle kth species

S34 = -S34 as used by this code

POLYDISPERSE

NT,ST [Read only if ITAPE≠0; for ITAPE=0, values are taken from card input.]

$$I=1,NT\left\{\begin{array}{l} \text{REFACT,ALPHA,QSCA,COSBAR,QEXT} \\ \text{J=1,NK(K)}\ \{\text{XA,AA,BB,XX3,XX4,YY,XX2} \end{array}\right.$$

NT = number of steps in size

ST = dimensionless step size = $\frac{\pi}{\lambda}$ x δd where δd is the step size in diameter (microns)

REFACT,ALPHA,QSCA,COSBAR,QEXT as described under MONODISPERSE input

XA = scattering angle (degrees)

AA,BB - not used

$$\left.\begin{array}{l} XX3 = S33 \\ XX4 = -S34 \\ YY = S11 \\ XX2 = S12 \end{array}\right\}$$ Scattering matrix elements for size parameter ALPHA, scattering angle XA

SECTION 6.0
CTRANS PROGRAM LISTING

```
     6324Y201
              19-NOV-76   BACKLOG    CPU/IO     STANDBY  CPU/IO      IDLE    DOWN    OP. PROBLEMS
                 360/91      7  05.25/04.25   28  10.53/ 5.37   0.00    1.42      LAST WEEK
                 360/75      0   0.00/ 0.00    7  09.50/ 0.23   0.00   00.00          2

     6324H211
           ********         N O T I C E     P L E A S E     N O T I C E          *******
              M N L L O A D  I S  N C A  S Y S 2 . L O A D  O N  3 6 0 / 9 1  A N D  / 7 5
                 ******                                                  *****
                      R E T E N T I O N   C A R D S   A R E   D U E   TUE. NOV. 30, 1976
                 CONDENSE  AEN. DEC. 1, 1976  0800.
           ****   SYS2.LOADLIB         BLD. #1   FLCM   " 251   SYS2.LOADLIB   *******

     6320KA04
           ****************************************************************************
           *                           IMPROVED VSCOPY PROGRAM                         *
           ****************************************************************************
           *     AN IMPROVED VERSION OF THE VSCOPY PROGRAM HAS BEEN INSTALLED ON BOTH  *
           *  MACHINES.  THE PROCEDURES WHICH USE THE VSCOPY PROGRAM ARE: VSCOPY, BACKUP, *
           *  AND RESAVE.                                                               *
           *     PLEASE REPORT ANY PROBLEMS TO THE FAC, X6538.                          *
           ****************************************************************************

  //ZCRATFCL JOB (S0211604A,P,HA0001,C03C05),WLF                          WLFAC185
  ***PEARCE FCLALB
  // EXEC FORTRANH,PARM='XREF,MAP,ID,OPT=2',REGION=360K
  XXDEFAULT PROC FORTRAN=IEKAA00,NOLK=40,OUT=A,BLKSIZE=7265 * 15 OCT 74 * 00000100
  XXSOURCE EXEC PGM=&FORTRAN,REGION=250K,PARM='OPT=2'        * FORTRANH *  00000200
  IEF653I SUBSTITUTION JCL - PGM=IEKAA00,REGION=250K,PARM='OPT=2'
  XXSTEPLIB DD DSN=SYS1.FORTH,DISP=SHR                                     00000300
  XXSYSLIN DD DSN=&&OBJMOD,DISP=(MOD,PASS),UNIT=2314,                     00000400
  XX SPACE=(3200,(&NOLK,40),,ROUND),DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200) 00000500
  IEF653I SUBSTITUTION JCL - SPACE=(3200,(40,40),,ROUND),DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)
  XXSYSPRINT DD SYSOUT=&OUT,UNIT=(2314,SEP=SYSLIN),                       00000600
  IEF653I SUBSTITUTION JCL - SYSOUT=A,UNIT=(2314,SEP=SYSLIN),
  XX DCB=(RECFM=VBA,LRECL=137,BLKSIZE=&BLKSIZE)                           00000700
  IEF653I SUBSTITUTION JCL - DCB=(RECFM=VBA,LRECL=137,BLKSIZE=7265)
  XXSYSPUNCH DD SYSOUT=B,DCB=(RECFM=FB,LRECL=80,BLKSIZE=7280)             00000800
  XXSYSUT1 DD UNIT=(2314,SEP=(SYSLIN,SYSPRINT)),SPACE=(CYL,(1,1))        00000900
  XXSYSUT2 DD UNIT=(2314,SEP=(SYSLIN,SYSPRINT,SYSUT1)),SPACE=(CYL,(1,1)) 00001000
  //SOURCE.SYSIN DD *
IEF236I ALLOC. FOR ZCRATFCL SOURCE
IEF237I 332   ALLOCATED TO STEPLIB
IEF237I 212   ALLOCATED TO SYSLIN
IEF237I 213   ALLOCATED TO SYSPRINT
IEF237I 216   ALLOCATED TO SYSPUNCH
IEF237I 231   ALLOCATED TO SYSUT1
IEF237I 216   ALLOCATED TO SYSUT2
IEF237I 213   ALLOCATED TO SYSIN

  LEVEL 21.6 (DEC 72)                  OS/360 FORTRAN H                      DATE 76.324/21.44.32

       COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                          SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
            C*****
            C*****
            C*****
            C*****                   C T R A N S
            C*****
            C*****
            C*****
            C*****       THIS PROGRAM COMPUTES THE CONTRIBUTION OF MULTIPLE
            C*****SCATTERED RADIATION TO A GENERALIZED RECEIVER IN A PLANE
            C*****PARALLEL GEOMETRY
            C*****
            C*****       THE AMBIANT ATMOSPHERE CONSISTS OF (UP TO 100) PLANE PARALLEL
            C*****HOMOGENEOUS LAYERS CONTAINING (UP TO 5) ACTIVE SCATTERING SPECIES.
            C*****REGIONS OF INHOMOGENEITY ( CLOUDS ) MAY BE SUPERIMPOSED ON
            C*****THE AMBIANT ATMOSPHERE.  EACH CLOUD IS A RECTANGULAR SOLID WITH
            C*****TOP AND BOTTOM FACES PARALLEL WITH THE EARTH.  CLOUDS MAY
            C*****NOT OVERLAP EACH OTHER.  EACH CLOUD IS ASSIGNED AN INDIVIDUAL
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
C*****DENSITY AND ACTIVE SCATTERING SPECIES (ONE OF THE ALLOWED 5) IN
C*****ADDITION TO THE AMBIANT ATMOSPHERE.
C*****    THE PROGRAM ACCEPTS AS INPUT THE DENSITIES OF OZONE,
C*****MOLECULAR SCATTERERS, HAZE, AND AEROSOLS AS A FUNCTION OF ALTITUDE
C*****TOGETHER WITH THE SIZE DISTRIBUTION PARAMETERS OF THE HAZE AND
C*****AEROSOLS.
C*****    THE RECEIVER MAY BE
C*****        1)  ANY FACE OF ANY CLOUD, POINTING INTO OR
C*****            OUT OF THE CLOUD
C*****            OR
C*****        2) INFINITESSIMAL IN AREA AT A SPECIFIED ALTITUDE (HR)
C*****       WITH A SPECIFIED ZENITH COSINE
C*****THE FIELD OF VIEW OF THE RECEIVER MAY BE SPECIFIED (0. TO
C*****PI RADIANS)
C*****
C*****    CTRANS EMPLOYES THE BACKWARDS TRACKING METHOD, TRACKING PHOTONS
C*****BACKWARDS FROM THE RECEIVER TOWARDS THE SUN AND ACCUMULATING THE
C*****ELEMENTS OF THE SCATTERING TRANSFORT MATRIX.  WHEN A SCATTERING
C*****IS CALLED, WE SAMPLE PHOTONS HYPOTHETICALLY SCATTERED
C*****INTO EACH OF THE SPECIFIED SOLAR DIRECTIONS AND WEIGHT THEM
C*****BY THE PROBABILITY OF THE OCCURRANCE.
C*****
C*****THE SCATTERING PARTICLE DENSITY AND SIZE DISTRIBUTION INFORMATION
C*****IS PRESENTED IN TABULAR FORM FOR A STRATIFIED ATMOSPHERE AND THE
C*****SCATTERING MATRIX ELEMENTS ARE COMPUTED FOR EACH OF THE FOUR
C*****SCATTERER TYPES.  IT IS ASSUMED THAT THE SIZE DISTRIBUTION SHAPES
C*****DO NOT CHANGE WITH ALTITUDE.
C*****    SCATTERING OCCURRENCES ARE SELECTED ON THE BASIS OF THE
C*****COMPUTED TOTAL EXTINCTION CROSS SECTION.  THE TRUE NATURE OF THE
C*****SCATTERER (MOLECULAR, OZONE, HAZE OR AEROSOL) IS SELECTED AT RANDOM
C*****ACCORDING TO THEIR RELATIVE CONTRIBUTIONS TO THE TOTAL CROSS SECTION.
C*****THE APPROPRIATE SCATTERING MATRIX ELEMENTS ARE THEN EMPLOYED TO
C*****EVALUATE THE CONTRIBUTION OF THIS SCATTERING TO THE SAMPLED
C*****CUMULATIVE SCATTERING MATRIX AT ALL OF THE SPECIFIED SUNS
C*****     GROUND REFLECTION IS GENERALIZED AS FOLLOWS--
C*****THE TYPE OF REFLECTANCE IS SPECIFIED BY A REFLECTANCE TYPE MAP.
C*****PERMITTED MAPS ARE
C*****       1) UNIFORM PLANE
C*****       2) UNIFORM HALF PLANES
C*****       3) RECTANGULAR NON-OVERLAPPING RECTANGULAR REGIONS ON A
C*****          BACKGROUND FIELD
C***** REFLECTANCE TYPES ALLOWED ARE
C*****       1) LAMBERTIAN
C*****       2) FRESNEL REFLECTANCE FROM A ROUGH SURFACE WITH
C*****          GAUSSIAN SLOPE DISTRIBUTION
C*****          (SHADOWING AND HIDING ARE IGNORED )
C*****FOR LAMBERTIAN REGIONS UP TO 50 OVERLYING MAPS OF THE
C*****LAMBERTIAN ALBEDO ARE ALLOWED. ALL ROUGH FRESNEL REGIONS SHARE
C*****THE SAME PARAMETRIC SPECIFICATION
C*****    THE INPUT PARAMETERS ARE AS FOLLOW:
C*****    IND = CALCULATION EXTENT INDICATOR
C*****        =0 STOP CALCULATION
C*****        =1 CALCULATE FOR RECEIVER  POINTING BOTH INTO AND OUT OF
C*****           CLOUD
C*****         ***NOTE-- THIS OPTION HAS BEEN DISABLED TO ALLOW GREATER
C*****                   STORAGE
C*****    IND =2 INPUT NEW CLOUDS AND NEW RECEIVERS
C*****        = 4 NORMAL START
C*****        = 5 OMIT POLARIZATION, SET S(I,J)=0. FOR I,J.NE.1
C*****        = 6 CALCULATE ONLY FOR GROUND ALBEDO = 0.
C*****        = 7 ZERO ALBEDO AND NO POLARIZATION
```



```
C*****             IST      NEW ATMOSPHERE INDICATOR
C*****                 =1  READ NEW ATMOSPHERE
C*****                 =0  USE ONE ALREADY READ IN
C*****    ISKY=0  USER SPECIFIED SUNS (MAXIMUM OF 15)
C*****    ISKY=1  SUNS AT THETA =0,30,60, PHI=0
C*****    ISKY=2  SUNS AT THETA =0,30,60, PHI=PI/4
C*****    ISKY=3  SUNS AT THETA =0,30,60, PHI=PI/2
C*****    INFLUX=INDICATOR GOVERNING CALCULATED VALUES
C*****          =0 CALCULATE FLUX AT RECEIVER
C*****          =1 CALCULATE SPECIFIC INTENSITY AT RECEIVER
C*****    WAV = WAVELENGTH OF THE RADIATION IN MICRONS
C*****    INDIC(K)= INDICATOR FOR TYPE OF KTH SPECIES
C*****            = 5 OR MORE IF SPECIES IS NOT PRESENT.
C*****            = 0 FOR RAYLEIGH (MATRIX ELEMENTS COMPUTED)
C*****            = 1 FOR MONODISPERSE MIE (MATRIX ELEMENTS READ FROM
```

```
C*****            BINARY TAPE)
C*****          = 2 FOR POLYDISPERSE MIE (MATRIX ELEMENTS COMPUTED
C*****            WHILE READING BINARY TAPE)
C*****          = 3 FOR EXPERIMENTAL DATA (MATRIX ELEMENTS READ FROM
C*****            CARDS)
C*****          = 4 FOR OZONE (ABSORPTION ONLY)
C*****              NLAYER= NUMBER OF STRATIFIED LAYERS OF ATMOSPHERE
C*****                      TO BE CONSIDERED
C*****    IDIST(K)= DISTRIBUTION INDICATOR
C*****          = 1 FOR JUNGE DISTRIBUTION.
C*****          = 2 FOR DEIRMENDJIAN'S HAZE MODEL.
C*****          = 3 FOR LOGNORMAL DISTRIBUTION.
C*****          = 4 FOR HAZE C (JUNGE WITH PEDESTAL)
C*****    NLAYER = NUMBER OF AMBIENT ATMOSPHERIC LAYERS
C*****    NSOL = NUMBER OF SUNS
C*****    NMAX = NUMBER OF PHOTONS TO BE TRACKED
C*****    NSCA = MAX NUMBER OF SCATTERINGS ALLOWED PER TRACK
C*****    NALB = NUMBER OF LAMBERTIAN ALBEDO PATTERNS
C*****    IUNIT(K) = INPUT TAPE UNIT DESIGNATOR FOR KTH SPECIES
C*****    NTOT(K) = NUMBER OF DIAMETER INTERVALS FOR POLYDISPERSION
C*****    INDICA(K) = INDICATOR OF TYPE OF KTH SPECIES FOR AMBIENT ATM.
C*****              CODE HAS SAME MEANING AS INDIC. ANY TYPE PRESENT
C*****             IN INDICA MUST BE PRESENT IN INDIC.
C*****    SCALE(K)=0.     USE CROSS SECTIONS AS OTHERWISE READ IN AND/OR
C*****                    COMPUTED
C*****            .GT.0.  SCALE CROSS SECTION OF AMBIENT ATMOSPHERIC
C*****                    COMPONENT K SO THAT THE TOTAL VERTICAL OPTICAL
C*****                    DENSITY OF COMPONENT K = SCALE(K)
C*****    AR,BR = RAYLEIGH CROSS SECT. PARAMS.--SIGMA=AR*1.E-28*(LAMBDA)**-BR
C*****    ADEF = OZONE CROSS SECTION
C*****    EXPFAC = MOLECULAR SCALE HEIGHT ADJUSTMENT
C*****    INDOZ = 0  OZONE DENSITIES (CM**-3) ARE READ IN
C*****         .NE.0  OZONE PARTIAL PRESSURES ARE READ IN
C*****          = 1  OZONE DENSITIES COMPUTED FROM PARTIAL PRESSURES
C*****               ARE TEMPERATURE CORRECTED
C*****    SOLC = SOLAR CONSTANT ASSUMED FOR NORMALIZATION.
C*****          IF SOLC = 0 (OR BLANK) ON INPUT, A VALUE OF 1.0
C*****          IS ASSUMED
C*****    THETA(K),PHI(K) = SOLAR DIRECTION FOR KTH SUN
C*****    NK(K) = NUMBER OF TABULATED ANGLES FOR KTH TYPE SCATTERER
C*****    A1(K),B1(K),C1(K)= PARAMETERS OF THE DISTRIBUTION FUNCTION (IF
C*****                       INDIC(K)=2)
C*****    ITAPE(K)=0 USE NTOT(K),STEP(K) AS READ FROM CARDS
C*****            =1 READ NTOT(K) (=NT) AND STEP(K) FROM MIE TAPE
C*****    S11(I,K)= S11 MATRIX ELEMENT FOR THE KTH SPECIES AND THE ITH
C*****              SCATTERING ANGLE (NORMALIZED SO THAT THE INTEGRAL IS
C*****              UNITY)
C*****    S12(I,K,L)= S12 MATRIX ELEMENT FOR THE KTH SPECIES AND ITH
C*****              ANGLE
C*****    S22(I,K,L)= S22 MATRIX ELEMENT FOR THE KTH SPECIES AND ITH
C*****              ANGLE
C*****    S33(I,K,L)= S33 MATRIX ELEMENT FOR THE KTH SPECIES AND ITH
C*****              ANGLE
C*****    S34(I,K,L)= S34 MATRIX ELEMENT FOR THE KTH SPECIES AND ITH
C*****              ANGLE
C*****    S44(I,K,L)= S44 MATRIX ELEMENT FOR THE KTH SPECIES AND ITH
C*****              ANGLE
C*****             (IF L=1 RESULTS ARE NORMALIZED AS S11 BUT IF L=2 THE
C*****              MATRIX ELEMENTS ARE DIVIDED BY THE CORRESPONDING S11
C*****              ELEMENTS)
C*****    X(K,I)  = ITH SCATTERING ANGLE(IN RADIANS)FOR THE KTH SPECIES
C*****    CSECT(K)= EXTINCTION CROSS-SECTION OF KTH SPECIES
C*****    ASECT(K)= ABSORPTION CROSS-SECTION OF KTH SPECIES
C*****    XH(J) = LAYER TOP HEIGHT OF JTH AMBIENT ATM. LAYER (KM.)
C*****    TEMP(J) = TEMPERATURE (DEG.K.) OF JTH AMB. ATM. LAYER
```



```
C*****            DENS(1,I)= DENSITY OF OZONE MOLECULES IN THE I TH
C*****                       STRATIFICATION LAYER
C*****            DENS(2,I)= MOLECULAR DENSITY IN THE I TH STRATIFICATI
C*****                       LAYER
C*****            DENS(3,I)= DENSITY OF AEROSOL PARTICLES IN THE I TH
C*****                       STRATIFICATION LAYER
C*****            DENS(4,I)= DENSITY OF HAZE PARTICLES IN THE I TH
C*****                       STRATIFICATION LAYER
C*****            DENS(5,I)= DENSITY OF OTHER SPECIES IN THE I TH
C*****                       STRATIFICATION LAYER
C*****    NCLOUD = NUMBER OF CLOUDS
C*****    HC(I) = HEIGHT OF BOTTOM OF ITH CLOUD
```

```
C*****    AC(I),BC(I),CC(I) = EDGE LENGTH OF ITH CLOUD
C*****    XCL(I),YCL(I) = C.M. CO-ORDINATES OF ITH CLOUD
C*****    THETAC(I) = ORIENTATION ANGLE OF ITH CLOUD
C*****    INC(I) = DESIGNATOR OF SCATTERING CONSTITUENT OF ITH CLOUD
C*****    CLDEN(I) = DENSITY OF SCATTERERS IN ITH CLOUD (CM**-3)
C*****    IRCLD  =  RECEIVER POSITION LOCATER INDEX
C*****          =0    RECEIVER WITH INFINITESIMAL AREA LOCATED AT
C*****                ALTITUDE HR, WITH ZENITH COSINE = CZO
C*****         = J  (J.GT.0) LOCATED ON CLOUD J
C*****    IREC  =  1 +X FACE OF CLOUD IRCLD
C*****    IREC  =  2 -X FACE OF CLOUD IRCLD
C*****    IREC  =  3 +Y FACE OF CLOUD IRCLD
C*****    IREC  =  4 -Y FACE OF CLOUD IRCLD
C*****    IREC  =  5 +Z FACE OF CLOUD IRCLD
C*****    IREC  =  6 -Z FACE OF CLOUD IRCLD
C*****    IREC .LT.0 POINTING OUT OF CLOUD LOCATED ON FACE AS
C*****                INDICATED ABOVE
C*****    RECANG = APEX ANGLE OF CONICAL RECEIVER FIELD OF VIEW
C*****    ( IN MILLIRADIANS )
C*****                HR = ALTITUDE OF THE RECEIVER
C*****           (IGNORED IF RECEIVER IS A CLOUD FACE)
C*****                CZO= THE COSINE OF THE ZENITH ANGLE OF RECEIVER
C*****           (IGNORED IF RECEIVER IS A CLOUD FACE)
C*****    RPHI = AZIMUTHAL ANGLE OF PLANE CONTAINING VERTICAL
C*****           AND CENTER OF RECEIVER FIELD OF VIEW
C*****             (IGNORED IF RECEIVER IS A CLOUD FACE)
C*****    RX,RY = X,Y COORDINATES OF RECEIVER
C*****             (IGNORED IF RECEIVER IS A CLOUD FACE)
C*****    SZC = SINE OF ZENITH RECEIVER ANGLE
C*****         = 0. OR BLANK -- SZC IS COMPUTED FROM CZO
C*****        .NE.0. CZO IS COMPUTED FROM SZC
C*****             (IGNORED IF RECEIVER IS A CLOUD FACE)
C       CONTRIBUTION MAP PARAMETERS
C       IF RECANG .GT. 0. , IMAP=1 AND MAPPING TAKES PLACE
C       IAPAT = INDEX OF ALBEDO PATTERN TO BE MAPPED
C              DEFAULT-- IAPAT=1        (MAX=50)
C       NCON = NUMBER OF THETA BINS = NUMBER OF PHI BINS
C              DEFAULT = 20      (MAX=20)
C***** GROUND REFLECTANCE PARAMETERS
C*****
C*****    IRPAT = 0 UNIFORM PLANE (=BACKGROUND)
C*****          =+1 GROUND DIFFERS FROM BACKGROUND FOR X.GT.XBND
C*****          =-1 GROUND DIFFERS FROM BACKGROUND FOR X .LT. XBND
C*****          = 2 GROUND DIFFERS FROM BACKGROUND WITHIN
C*****              SPECIFIED RECTANGLES (1 TO 20 ALLOWED)
C*****    IRBGD = 0 BACKGROUND = LAMBERTIAN
C*****          =1 BACKGROUND = ROUGH FRESNEL
C*****    XBND = BOUNDARY LINE FOR HALF-PLANE PATTERN
C*****           (PARALLEL TO Y-AXIS )
C*****    FN = INDEX OF REFRACTION FOR FRESNEL REFLECTANCE
C*****    WSPD = WIND SPEED (M/SEC.)
C*****    WSIG2 = VARIANCE FOR GAUSSIAN SLOPE DISTRIBUTION
C*****          = WC0+WC1*WSPD
C*****          DEFAULT VALUES-- WC0=.0015, WC1=2.54E-03
C*****          .NE.0 VALUE OVERIDES WC0,WC1,WSPD SPECIFICATION
C*****  FOR INSET RECTANGLES PATTERN --
C*****      CNTRX(20),CNTRY(20) = (X,Y) CO-ORDINATES OF RECTANGLE CENTERS
C*****      EDGEX(20),EDGEY(20) = X,Y EDGE LENGTHS OF RECTANGLES
C
C----           DICTIONARY OF OTHER PARAMETERS USED (BUT NOT INPUT)
C
C*****    CDF(I,K)= CUMULATIVE DISTRIBUTION FUNCTION FOR THE PROBABILITY
C*****              ENCOUNTER WITH KTH SPECIES SCATTERER IN ITH LAYER
C*****    CIN(I) = SIX-VECTOR PHOTON DESCRIPTOR--I=1,2,3 PHOTON CO-ORDS
C*****              I=4,5,6 FLIGHT DIRECTION COSINES
C*****    NCLUMP = NUMBER OF PHOTON TRACKS PER CLUMP
C*****    SCLT = CUMULATIVE SCATTERING MATRIX
C*****    TOR(I)  = OPTICAL THICKNESS OF ITH LAYER(IN THE VERTICAL
```



```
C*****              DIRECTION)
C*****    TORT(I) = OPTICAL THICKNESS OF TOP OF ITH LAYER MEASURED AS
C*****              FOR TORS(J)
C*****    US(J), VS(J),WS(J)= DIRECTION COSINES OF THE SOLAR ANGLES
C*****              TO BE CONSIDERED
C*****    VSAMP = SAMPLE MATRIX
C*****    WSUN = IN-CLOUD SOLAR DIRECTIONS
C     INPUT CARDS
C       INITIAL RANDOM NUMBER (MAY BE BLANK)
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
      C          (I7)
      C          IND,IST,ISKY,INFLUX,WAV
      C             (4I1,F8.5)
      C          INDIC(5),IDIST(5),NLAYER,NSCL,KMAX,NSCA,NALB,IUNIT(5),NTCT(5)
      C             (10I1,3I3,I6,7I2,5I3)
      C          INDICA(5)
      C             (5I1)
      C          SCALE(5)
      C             (5E11.6)
      C          AR,BR
      C             (2F8.6)
      C          ADEF,EXPFAC
      C             (2F8.5)
      C          INDCZ,INDCCZ
      C             (2I1)
      C          SOLC
      C             (F10.6)
      C            (IF ISKY=0)
      C          THETA(1),PHI(1)
      C             (F7.4,F7.2)
      C          .
      C          .
      C          .
      C          THETA(NSCL),PHI(NSCL)
      C          NK(1),STEP(1),A1(1),B1(1),C1(1),ITAPE(1)
      C             (I3,4F8.3,I1)
      C          .
      C          .
      C          .
      C          NK(KMAX),STEP(KMAX),A1(KMAX),....
      C          XH(1),TEMP(1)
      C             (F3.0,2X,F3.0)
      C          .
      C          .
      C          .
      C          XH(NLAYER),TEMP(NLAYER)
      C          XH(1),DENS(1,1)
      C             (F3.0,2X,E9.3)
      C          .
      C          .
      C          .
      C          XH(NLAYER),DENS(1,NLAYER)
      C          .
      C          .
      C          .
      C          XH(NLAYER),DENS(KMAX,NLAYER)
      C          NCLOUD
      C             (I3)
      C          HC(1),AC(1),BC(1),CC(1),XCL(1),YCL(1),THETAC(1),INC(1),CLDEN(1)
      C             (F8.5,5F8.3,F8.5,I3,E9.3)
      C          .
      C          .
      C          .
      C          HC(NCLOUD),AC(NCLOUD),....
      C         IRCLD,IREC,RECANG,HR,CZC,RPHI,RX,RY,S20,IAPAT,NCON
      C             (2I2,7E10.4,2I2)
      C          IRPAT,IRECD,XBND,FN,WSFD,WC0,WC1,WSIG2
      C             (2I2,6E11.4)
      C          THE FOLLOWING ARE REQUIRED IF IRPAT = 2
      C             NSPOT
      C                (I3)
      C             CNTRX(1),CNTRY(1),EDGEX(1),EDGEY(1)
      C                (4E11.4)
      C             .
      C             .
      C             .
      C             CNTRX(NSPOT),....
      C*****
      C*****
ISN 0002          DIMENSION DSUNT(15),DSUNP(15),ETA(15),TSUN(15),PSUN(15)
ISN 0003          DIMENSION LCSNUM(20,20)
```

ORIGINAL PAGE IS
OF POOR QUALITY


```
ISN 0004          DIMENSION NUMAP(20,20),CCNMAP(20,20,15),PHMAP(20),THMAP(20)
ISN 0005          DIMENSION              X(5,100),S11(100,5),S12(100,5,2),
                 1S22(100,5,2),S33(100,5,2),S34(100,5,2),S44(100,5,2),
                 3X1(5,100),Y1(5,100)
ISN 0006          DIMENSION CDF(5,100)
ISN 0007          DIMENSION COUT(6)
```

```
ISN 0008          DIMENSION VSA(4,5,3,1),VSAMP(4,5,3,1,50),VSAMP3(4,5,3,1,50)
                 *,VSAMP2(4,5,3,1,50)
ISN 0009          DIMENSION SCLPY(16)
ISN 0010          DIMENSION NUMSCA(200)
ISN 0011          DIMENSION SCLRIR(6)
ISN 0012          COMMON S11, S12, S22, S33, S34, S44, X, X1, Y1, CDF
ISN 0013          COMMON/INPCHT/IMP,IMPX,IMPJ,TAWSUN,THSBR,SDTH
ISN 0014          COMMON/SPTLIT/IHBAR
ISN 0015          COMMON/TST/ITEST
ISN 0016          COMMON/CTAB/VSAMP4(4,15,15,2),VSAMP5(4,15,2)
ISN 0017          COMMON/SCRCLL/IRAND
ISN 0018          COMMON/SCL/NSUL,WSUN(11,15,3),US(15),VS(15),WS(15)
ISN 0019          COMMON/PHCT/CIN(6),UN,VN,WN,JJ,SCLT(16),INCLD
ISN 0020          COMMON/ATM/NLAYER,TUR(100),TCRT(100),TOL(100),XF(100),DX(100)
ISN 0021          COMMON/SCAT/N,INDIC(5),JK,IGND
ISN 0022          COMMON/PARAM/IND,NSCA,NK(5),NUNK(5),KMAX,IST,WAV,FACTCR,NM
                 1,NMAX
ISN 0023          COMMON/ACC/AC1,AC2,AC3
ISN 0024          COMMON/GND/NALB,ALB(50),CG(2)
ISN 0025          COMMON/FIL/ACEN
ISN 0026          COMMON/WT/WEIGHT
ISN 0027          COMMON/CLFAR/NCLOUD,NCLDI,CLCUC(10,10)
ISN 0028          COMMON/CRDNTS/COORD(6),CLCCRD(6)
ISN 0029          COMMON/CLDATM/INC(10),TCLCLD(10),ACLD(10)
ISN 0030          COMMON/RCVR/IRCLD,IREC,RECANG,CREC,HR,CZC,IFC1,IFC2,IFC3,
                 *CINR(6),UNR,VNR,WNR,FACTR,FCINTF,CHT
                 *,INFLUX,SZC
ISN 0031          COMMON/CCNST/PI,TPI
ISN 0032          COMMON/INCUT/IIREC(2)
ISN 0033          COMMON/MAPCON/NCON,IAFAT
ISN 0034          COMMON/GNDHIT/ISCAT,IRCCD
ISN 0035          CALL RENTIM(ITIME,ICTIM)
            C
            C     SET UP CONSTANTS
            C
ISN 0036          IIKTM=0
ISN 0037          ISMTM=0
ISN 0038          ITLIM=15
ISN 0039          IAPAT=1
ISN 0040          TAUS=0.
ISN 0041          PI=3.14159
ISN 0042          TPI=2.*PI
ISN 0043          FACT=.25
ISN 0044          AC1=0.
ISN 0045          AC2=0.
ISN 0046          AC3=0.
ISN 0047          NCON=20
ISN 0048          NCLUMP=1
ISN 0049          IMAP=0
            C
            C     SEED RANDOM NUMBER
            C
ISN 0050          READ(5,102)IX
ISN 0051      102 FORMAT(I7)
ISN 0052          IF(IX.EQ.0)IX=65549
ISN 0054        1 READ(5,100)IND,IST,ISKY,INFLUX,WAV
ISN 0055          IF(IND.EQ.0)STOP
ISN 0057      100 FORMAT(4I1,F6.5)
ISN 0058          IMP=0
            C
            C     CLEAR OUT SAMPLING MATRIX
            C
ISN 0059          DO 111 IALB=1,50
ISN 0060          DO 111 I=1,4
ISN 0061          DO 111 J=1,5
ISN 0062          DO 111 K=1,3
ISN 0063          L=1
ISN 0064          VSAMP2(I,J,K,L,IALB)=0.
ISN 0065          VSAMP3(I,J,K,L,IALB)=0.
ISN 0066      111 VSAMP(I,J,K,L,IALB)=0.
ISN 0067          DO 112 ICUV=1,4
ISN 0068          DO 112 ISUN=1,15
ISN 0069          DO 112 KK=1,2
ISN 0070          VSAMP5(ICUV,ISUN,KK)=0.
```



```
ISN 0071          DO 112 JSUN=1,15
ISN 0072          VSAMP4(ICUV,ISUN,JSUN,KK)=0.
```

```
ISN 0073      112 CONTINUE
ISN 0074          DO 55 ITH=1,20
ISN 0075          PHMAP(ITH)=0.
ISN 0076          THMAP(ITH)=0.
ISN 0077          DO 55 JTH=1,20
ISN 0078          LOSNUM(ITH,JTH)=0
ISN 0079          NUMAP(ITH,JTH)=0
ISN 0080          DO 55 ISN=1,15
ISN 0081          CONMAP(ITH,JTH,ISN)=0.
ISN 0082       55 CONTINUE
ISN 0083          KK=1
ISN 0084          DO 40 ISCA=1,200
ISN 0085       40 NUMSCA(ISCA)=0
              C
              C   READ LINE PAIR DESIGNATION UNDER STUDY
              C   AND ATMOSPHERE CHARACTERISTICS.  COMPUTE PARAMETERS REQUIRED
              C   LATER
              C
ISN 0086          IRAND=IX
ISN 0087          CALL INPUT(KK,ISKY)
ISN 0088          DTHC=RECANG/FLOAT(NCON)
ISN 0089          DPHC=2.*PI/FLOAT(NCON)
ISN 0090          DO 56 ITH=1,NCON
ISN 0091          PHMAP(ITH)=FLOAT(ITH)*DPHC
ISN 0092       56 THMAP(ITH)=FLOAT(ITH)*DTHC
ISN 0093          RMSTH=SQRT(THSQR)
ISN 0094          IIREC(KK)=0
ISN 0095          IMPJ=20
ISN 0096          IF(IRCLD.NE.0)IIREC(KK)=IREC
ISN 0098       70 CONTINUE
              C
              C   LOOP OVER NUMBER OF PHOTONS TO BE TRACKED
              C
ISN 0099          IMOD=MOD(NMAX,NCLUMP)
ISN 0100          IF(IMOD.NE.0) NMAX=NMAX+NCLUMP-IMOD
ISN 0102          AUEN=FLOAT(NMAX)
ISN 0103          DO 20 I=1,NMAX
              C
              C   INITIALIZE PHOTON
              C
ISN 0104          IMOD=MOD(I,NCLUMP)
ISN 0105          FCLUMP=1.
ISN 0106          ECLUMP=1.
ISN 0107          SBWT=1.
ISN 0108          DIRWT=1.
ISN 0109          INCLD=0
ISN 0110          IF(IRCLD.EQ.0)GO TO 420
              C
              C   START ON A CLOUD FACE
              C
ISN 0112          X2=1.
ISN 0113          Y2=1.
ISN 0114          CALL RANDU(IX,IY,X2)
ISN 0115          IX=IY
ISN 0116          CALL RANDU(IX,IY,Y2)
ISN 0117          IX=IY
ISN 0118      410 CIN(IFC1)=CLOUD(IRCLD,IFC1+3)*FACTR
ISN 0119          CIN(IFC2)=CLOUD(IRCLD,IFC2+3)*(X2-.5)*2.
ISN 0120          CIN(IFC3)=CLOUD(IRCLD,IFC3+3)*(Y2-.5)*2.
ISN 0121          SBWT=4.*CLOUD(IRCLD,IFC2+3)*CLOUD(IRCLD,IFC3+3)
ISN 0122          DIRWT=SBWT
ISN 0123          DO 419 IJ=4,6
ISN 0124      419 CIN(IJ)=CINR(IJ)
ISN 0125          IF(IREC.LT.9)GO TO 412
ISN 0127          INCLD=IRCLD
ISN 0128          CHT=CLOUD(IRCLD,3)
ISN 0129          GO TO 421
ISN 0130      412 INCLD=0
ISN 0131          DO 414 IJ=1,6
ISN 0132      414 CLCORD(IJ)=CIN(IJ)
ISN 0133          INDC=+1
ISN 0134          CALL TRANS(IRCLD,INDC)
ISN 0135          DO 413 IJ=1,6
ISN 0136      413 CIN(IJ)=CCORD(IJ)
ISN 0137          CHT=0.
ISN 0138          GO TO 421
ISN 0139      420 DO 422 IJ=1,6
              C
```

```
                C
                C        START SOMEWHERE ELSE
                C
ISN 0140          422 CIN(IJ)=CINR(IJ)
ISN 0141              CHI=0.
ISN 0142          421 UN=UNR
ISN 0143              VN=VNR
ISN 0144              WN=WNR
ISN 0145              XTH=0.
ISN 0146              XPHI=0.
ISN 0147              CB=1.
ISN 0148              CALL RANDU(IX,IY,XTH)
ISN 0149              IX=IY
ISN 0150              CALL RANDU(IX,IY,XPHI)
ISN 0151              IX=IY
ISN 0152              IF(IRCLD.EQ.0)GO TO 427
                C
                C           CLOUD FACE DISTRIBUTION
                C
ISN 0154              RECTH=RECANG
ISN 0155           71 CONTINUE
ISN 0156              THETA=XTH*RECTH
ISN 0157              PHI=TPI*XPHI
ISN 0158              SBWT=SBWT*2.*PI*RECTH
ISN 0159           75 CONTINUE
ISN 0160              THIN=THETA
ISN 0161              PHIN=PHI
ISN 0162              IMAP=1
ISN 0163              DO 50 ICON=1,NCON
ISN 0164              ITHC=ICON
ISN 0165           50 IF(THIN.LE.THMAP(ICON))GO TO 51
ISN 0167           51 DO 52 JCON=1,NCON
ISN 0168              IPHC=JCON
ISN 0169           52 IF(PHIN.LE.PHMAP(JCON))GO TO 53
ISN 0171           53 CONTINUE
ISN 0172              NUMAP(ITHC,IPHC)=NUMAP(ITHC,IPHC)+1
ISN 0173              SB=SIN(THETA)
ISN 0174              CB=COS(THETA)
ISN 0175              SP=SIN(PHI)
ISN 0176              CP=COS(PHI)
                C
                C           BY FLUX, WE MEAN THE QUANTITY F IN CHANDRASEKHAR,
                C           'RADIATIVE TRANSFER', P3, EQ.(9) EXCEPT THAT THE
                C           INTEGRATION  ONLY GOES OVER 2*PI RADIANS
                C
ISN 0177              SBWT=SBWT*CB*SB
ISN 0178              GO TO 428
ISN 0179          427 CONTINUE
                C
                C           SPECIFIC RECEIVER
                C
                C           INFINITESSIMAL FIELD OF VIEW
                C
ISN 0180              IF(RECANG.EQ.0.)IMAP=0
ISN 0182              IF(RECANG.EQ.0.)GO TO 424
                C
                C           FINITE FIELD OF VIEW
                C
ISN 0184              SREC=SIN(RECANG)
ISN 0185              SB=SREC*SQRT(XTH*(XTH+2.*(1.-XTH)/(1.+CREC)))
ISN 0186              CB=1.-XTH*(1.-CREC)
ISN 0187              PHI=TPI*XPHI
ISN 0188              SP=SIN(PHI)
ISN 0189              CP=COS(PHI)
ISN 0190              THIN=ATAN2(SB,CB)
ISN 0191              PHIN=PHI
ISN 0192              IMAP=1
ISN 0193              DO 64 ICON=1,NCON
ISN 0194              ITHC=ICON
ISN 0195              IF(THIN.LE.THMAP(ICON))GO TO 65
ISN 0197           64 CONTINUE
ISN 0198           65 DO 66 JCON=1,NCON
ISN 0199              IPHC=JCON
ISN 0200              IF(PHIN.LE.PHMAP(JCON))GO TO 67
ISN 0202           66 CONTINUE
ISN 0203           67 CONTINUE
ISN 0204              NUMAP(ITHC,IPHC)=NUMAP(ITHC,IPHC)+1
ISN 0205              SBWT=TPI*(1.-CREC)
ISN 0206              SBAT=1.
ISN 0207              IF(INFLUX.EQ.0)SBWT=SBAT*CB
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0209       428 CONTINUE
ISN 0210           CALL JIM(COUT,CIN,CP,SP,C3,S8)
ISN 0211           DO 423 IJ=4,6
ISN 0212       423 CIN(IJ)=COUT(IJ)
ISN 0213       424 CONTINUE
ISN 0214           DO 425 J=1,NLAYER
ISN 0215           JJ=J
ISN 0216       425 IF(XH(J).GE.(CHT+CIN(3)))GO TO 426
ISN 0218       426 CONTINUE
ISN 0219           IUPDN=0
              C
              C    IF INITIAL CIN(6) .GT.0  FORWARDS TRACKED PHOTON WOULD BE
              C    GOING DOWN WHEN IT ENTERED RECEIVER
              C
ISN 0220           IF(CIN(6).GT.0.)IUPDN=1
ISN 0222           WEIGHT=1.
ISN 0223           WEIGHT=WEIGHT*SBWT
ISN 0224           WTIN=WEIGHT
              C
              C    INITIALIZE CUMULATIVE SCATTERING MATRIX
              C
ISN 0225           DO 21 J=2,16
ISN 0226        21 SOUT(J)=0.
ISN 0227           DO 211 J=1,16,5
ISN 0228       211 SOUT(J)=1.
              C
              C    INITIALIZE GROUND SCATTERING COUNTER (IGND)
              C
ISN 0229           IGND=0
              C
              C
              C    SAMPLE DIRECT SUN
              C
ISN 0230           DO 551 ISUN=1,NSUN
ISN 0231           ICL=NCLD1
ISN 0232           IF(INCLD.NE.0)ICL=INCLD
ISN 0234           COSAN=WSUN(ICL,ISUN,1)*CINR(4)+WSUN(ICL,ISUN,2)*CINR(5)+WSUN(ICL,I
                  *SUN,3)*CINR(6)
ISN 0235           IF(COSAN.LT.CPEC)GO TO 551
ISN 0237           IF(INCLD.EQ.0)GO TO 552
ISN 0239           DO 553 IJ=1,3
ISN 0240           IJ3=IJ+3
ISN 0241           CLCORD(IJ)=CIN(IJ)
ISN 0242       553 CLCORD(IJ3)=WSUN(ICL,ISUN,IJ)
ISN 0243           INDC=+1
ISN 0244           CALL TRANS(INCLD,INDC)
ISN 0245           GO TO 554
ISN 0246       552 DO 555 IJ=1,3
ISN 0247           IJ3=IJ+3
ISN 0248           CCORD(IJ)=CIN(IJ)
ISN 0249       555 CCORD(IJ3)=WSUN(ICL,ISUN,IJ)
ISN 0250       554 CONTINUE
ISN 0251           IF(COSAN.EQ.0.)GO TO 551
ISN 0253           CALL SEPSCL(TAUS)
ISN 0254           IF(TAUS.GT.150.)TAUS=150.
ISN 0256           DSAMP=EXP(-TAUS)*COSAN*4.*PI/ADEN
ISN 0257           IF(INFLUX.EQ.1)DSAMP=DSAMP/COSAN
ISN 0259           DSAMP=DSAMP*DIRWT
ISN 0260           DO 556 IALB=1,NALB
ISN 0261       556 VSAMP(1,ISUN,1,KK,IALB)=VSAMP(1,ISUN,1,KK,IALB)+DSAMP
ISN 0262       551 CONTINUE
ISN 0263           MSCA=-1
              C         INITIALIZE ALBEDO TRACK STORAGE
ISN 0264           DO 60 IALB=1,NALB
ISN 0265        60 ALB(IALB)=1.
              C    LOOP OVER ALLOWED NUMBER OF SCATTERINGS
              C
ISN 0266           ICNDF=1
ISN 0267           DO 22 ISCA=1,NSCA
ISN 0268           IMFX=IMP
ISN 0269           IF(IMP.EQ.2.AND.ISCA.GE.2)IMFX=0
ISN 0271           IF(IMP.EQ.3.AND.ISCA.LT.IMPJ)IMFX=0
ISN 0273           IF(ISCA.EQ.1.AND.INFLUX.EQ.1)IUFDN=0
ISN 0275           IF(ISCA.GT.1.AND.INFLUX.EQ.1)IUFDN=1
              C
ISN 0277           ICUT=0
              C
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                 C      DETERMINE DISTANCE TRAVELED BY PHOTON BETWEEN SCATT.
    ISN 0278     C      ISCAT=0
    ISN 0279            CALL TIME(ITK1)
    ISN 0280            IMN=0
    ISN 0281            IMX=0
    ISN 0282            ITEST=0
    ISN 0283            IF(I.LE.IMX.AND.I.GE.IMN)ITEST=1
    ISN 0285            CALL TRACK(IOUT,ISCAT,IX)
    ISN 0286            CALL TIME(ITK2)
    ISN 0287            ITKTM=ITKTM+ITK2-ITK1
                 C
                 C****
                 C                TEST PRINT SECTION ********
    ISN 0288            IF(ITEST.EQ.0)GO TO 600
    ISN 0290            WRITE(6,601)I,IOUT,ISCAT,IGND,WEIGHT,INCLD,UN,VN,WN
    ISN 0291            WRITE(6,606)ISCA
    ISN 0292            WRITE(6,602)(CIN(IPR),IPR=1,6)
    ISN 0293            WRITE(6,603)(COORD(IPR),IPR=1,6)
    ISN 0294            WRITE(6,604)(CLCORD(IPR),IPR=1,6)
    ISN 0295            IF(ISCAT.NE.0)WRITE(6,605)(CG(IPR),IPR=1,2)
    ISN 0297        606 FORMAT(1H ,5X,'ISCA=',I3)
    ISN 0298        601 FORMAT(1H0,'I=',I5,2X,'IOUT=',I2,2X,'ISCAT=',I2,2X,'IGND=',I5,2X,
                       .'WEIGHT=',E12.6,2X,'INCLD=',I3,2X,'UN=',E12.6,2X,'VN=',E12.6,2X,
                       .'WN=',E12.6)
    ISN 0299        602 FORMAT(1H ,5X,'CIN=',6E14.7)
    ISN 0300        603 FORMAT(1H ,5X,'COORD=',6E14.7)
    ISN 0301        604 FORMAT(1H ,5X,'CLCORD=',6E14.7)
    ISN 0302        605 FORMAT(1H ,5X,'CG=',2E14.7)
    ISN 0303        600 CONTINUE
                 C*****
                 C*****
    ISN 0304            IF(((IOUT.NE.0).AND.(ISCA.EQ.1)).AND.(IMAP.EQ.1))
                       .LOSNUM(ITHC,IPHC)=LOSNUM(ITHC,IPHC)+1
    ISN 0306            IF(IOUT.NE.0)GO TO 30
                 C           GROUND SCATTERING
                 C             UPDATE COUNTERS, DETERMINE TYPE OF REFLECTANCE, UPDATE
                 C             LAMBERTIAN ALBEDO WEIGHTS (IF LAMBERTIAN) , AND GO TO
                 C             SAMPLING SECTION
    ISN 0308            IF(ISCAT.EQ.0)GO TO 310
    ISN 0310            IF(IND.EQ.6.OR.IND.EQ.7)GO TO 30
    ISN 0312            MSCA=ISCA
    ISN 0313            IGND=IGND+1
    ISN 0314            CALL REFLCD(CG,IRCOD)
    ISN 0315            IF(IRCOD.NE.1)GO TO 62
    ISN 0317            DO 61 IALB=1,NALB
    ISN 0318            CALL ALBEDO(IALB,ALBPT)
    ISN 0319         61 ALB(IALB)=ALBPT*ALB(IALB)
    ISN 0320         62 CONTINUE
    ISN 0321            IF((ISCA.EQ.1.AND.ISCAT.EQ.1).AND.(INFLUX.EQ.1))IUPDN=-1
    ISN 0323            IF(ISCAT.NE.0)GO TO 25
    ISN 0325        310 CONTINUE
                 C
                 C      DETERMINE SCATTERING SPECIES
                 C
    ISN 0326            TCLD=0.
    ISN 0327            IF(INCLD.GT.0)TCLD=TCLCLD(INCLD)
    ISN 0329            SIGTOT=TCL(JJ)+TCLD
    ISN 0330            SIGCL=TCLD/SIGTOT
    ISN 0331            SIGATM=TCL(JJ)/SIGTOT
    ISN 0332            CALL RANDU(IX,IY,XX)
    ISN 0333            IX=IY
    ISN 0334            IF(XX.LE.SIGATM)GO TO 411
                 C
                 C      SCATTERER IS A CLOUD PARTICLE
                 C
    ISN 0336            JK=INC(INCLD)
    ISN 0337            WEIGHT=WEIGHT*(1.-ACLD(INCLD))
    ISN 0338            GO TO 24
    ISN 0339        411 CONTINUE
                 C
                 C      SCATTERER IS AN AMBIANT ATMOSPHERE PARTICLE
                 C
    ISN 0340            XX=XX/SIGATM
    ISN 0341            WW=1.-CDF(1,JJ)
    ISN 0342            WEIGHT=WEIGHT*WW
    ISN 0343            XX=CDF(1,JJ)+XX*WW
```

```
ISN 0344          DO 23 JJK=1,KMAX
ISN 0345          JK=JJK
ISN 0346          IF(XX.LE.CDF(JK,JJ))GO TO 24
ISN 0348       23 CONTINUE
ISN 0349       24 CONTINUE
ISN 0350          WTEF=WEIGHT/WTIN
ISN 0351          IF(WTEF.LE..002)GO TO 30
ISN 0353          N=NK(JK)
            C
            C     SAMPLE HYPOTHETICAL PHOTON TRAVELING TOWARDS SUN
            C
ISN 0354       25 CONTINUE
ISN 0355          CALL TIME(ISM1)
ISN 0356          CALL SAMPLE(VSAMP,KK,IUFON)
ISN 0357          CALL TIME(ISM2)
ISN 0358          ISMTM=ISMTM+ISM2-ISM1
            C
ISN 0359          MSCA=ISCA
ISN 0360          IF(ISCAT.NE.0)GO TO 401
ISN 0362      403 CONTINUE
            C
            C     DETERMINE SCATTERING ANGLE, BETA
            C
ISN 0363          CALL RANDU(IX,IY,XX)
ISN 0364          IX=IY
ISN 0365          CALL ANGLEM(BETA,XX)
            C
            C     GET AZIMUTHAL SCATTERING ANGLE, PHI
            C
ISN 0366          CALL RANDU(IX,IY,XX)
ISN 0367          IX=IY
ISN 0368          PHI=TPI*XX
ISN 0369          CB=COS(BETA)
ISN 0370          SB=SIN(BETA)
ISN 0371          CP=COS(PHI)
ISN 0372          SP=SIN(PHI)
            C
            C     COMPUTE DIRECTION COSINES AFTER SCATTERING AND LOCATION OF NEXT
            C     SCATTERING
            C
ISN 0373          CALL JIN(CCUT,CIN,CP,SP,CB,SB)
ISN 0374          GO TO 400
ISN 0375      401 CONTINUE
            C           DETERMINE SCATTERED DIRECTION FOR GROUND SCATTERING
ISN 0376          CALL RANDU(IX,IY,XPH)
ISN 0377          IX=IY
ISN 0378          CALL RANDU(IX,IY,XTH)
ISN 0379          IX=IY
ISN 0380          CALL GNDREF(CCUT,CIN,XTH,XPH,IRCOD)
ISN 0381      400 CONTINUE
            C
            C     UPDATE CUMULATIVE SCATTERING MATRIX AND DIRECTION COSINES
            C     AFTER SCATTERING
            C
ISN 0382          CALL RENEW(CCUT,BETA,CB)
ISN 0383       22 CONTINUE
            C
            C     WE HAVE FINISHED WITH THIS PHOTON
ISN 0384       30 CONTINUE
ISN 0385          IF(MSCA.LT.0)GO TO 31
ISN 0387          NUMSCA(MSCA)=NUMSCA(MSCA)+1
ISN 0388       31 CONTINUE
ISN 0389          IF(IMAP.NE.1)GO TO 57
ISN 0391          DO 54 ISUN=1,NSOL
ISN 0392       54 CONMAP(ITHC,IPHC,ISUN)=CONMAP(ITHC,IPHC,ISUN)+
                 .(VSAMP(1,ISUN,2,1,IAPAT)+VSAMP(1,ISUN,3,1,IAPAT))*.25/PI
ISN 0393       57 CONTINUE
ISN 0394          IF(IMOD.NE.0) GO TO 201
            C     ADD IN THIS CLUMP & RESTORE
ISN 0396          DO 200 I1=1,4
ISN 0397          DO 200 I2=1,NSOL
ISN 0398          DO 202 JSUN=1,12
ISN 0399          VSAMP4(I1,I2,JSUN,KK)=VSAMP4(I1,I2,JSUN,KK)+(VSAMP(I1,I2,1,KK,1)+
                 .VSAMP(I1,I2,2,KK,1)+VSAMP(I1,I2,3,KK,1))*(VSAMP(I1,JSUN,1,KK,1)+
                 .VSAMP(I1,JSUN,2,KK,1)+VSAMP(I1,JSUN,3,KK,1))
ISN 0400      202 CONTINUE
```

```
ISN 0402          VSAMP5(I1,I2,KK)=VSAMP5(I1,I2,KK)+(VSAMP(I1,I2,1,KK,1)+VSAMP(I1,I2
                 *,2,KK,1)+VSAMP(I1,I2,3,KK,1))**2
ISN 0403          ICV=2
ISN 0404          CALL OVERFL(IOV)
ISN 0405          IF(IOV.NE.2)WRITE(6,999)ICV,I1,I2,MSCA,
                 *I,IGND,
                 *VSAMP(I1,I2,1,1,1),VSAMP(I1,I2,2,1,1),VSAMP(I1,I2,3,1,1)
ISN 0407      999 FORMAT(1H ,'ICV=',I1,'ICOV=',I1,'ISUN=',I2,'MSCA=',I3,2X,
                 *'PHOT=',I6,'IGND=',I2,
                 *'VSAMP(1,2,AND3)=',3(E14.7,2X))
```



```
ISN 0408      203 CONTINUE
ISN 0409          DO 203 I3=1,3
ISN 0410          DO 203 I5=1,NALB
ISN 0411          VSAMP2(I1,I2,I3,KK,I5)=VSAMP2(I1,I2,I3,KK,I5)*FCLUMP+VSAMP(I1,I2,I
                 *3,KK,I5)*ECLUMP
ISN 0412          VSAMP3(I1,I2,I3,KK,I5)=VSAMP3(I1,I2,I3,KK,I5)+VSAMP(I1,I2,I3,KK,I5
                 *)*VSAMP(I1,I2,I3,KK,I5)
ISN 0413      200 CONTINUE
ISN 0414          DO 204 I1=1,4
ISN 0415          DO 204 I2=1,NSOL
ISN 0416          DO 204 I3=1,3
ISN 0417          DO 204 I5=1,NALB
ISN 0418      204 VSAMP(I1,I2,I3,KK,I5)=0.
ISN 0419          CALL REMTIM(ISTOP,ICTIM)
ISN 0420          NCPF=1
ISN 0421          IF(ISTOP.LE.ITLIM)GO TO 502
ISN 0423      201 CONTINUE
C
ISN 0424       20 CONTINUE
C
C                 WE HAVE TRACKED ALL THE PHOTONS FOR THIS CASE
C
ISN 0425          WRITE(6,670)(MSCA,NUMSCA(MSCA),MSCA=1,NSCA)
ISN 0426      670 FORMAT(1H0,'SCATTERING ORDER / FREQUENCY INFORMATION'/
                 *1H0,'ORDER',2X,'FREQUENCY'/200(1H ,I3,4X,I7/))
ISN 0427          MTOT=0
ISN 0428          DO 671 MSCA=1,NSCA
ISN 0429      671 MTOT=MTOT+MSCA*NUMSCA(MSCA)
ISN 0430          AVSCA=FLOAT(MTOT)/FLOAT(NMAX)
ISN 0431          WRITE(6,672)MTOT,AVSCA
ISN 0432      672 FORMAT(1H0,'TOTAL NUMBER OF SCATTERINGS = ',I10/
                 *1H ,'AVERAGE NUMBER OF SCATTERINGS PER PHOTON = ',G14.7)
C
C                    WRITE OUT MAPS OF CONTRIBUTIONS
C
ISN 0433          IF(IMAP.NE.1)GO TO 500
ISN 0435          WRITE(6,1050)
ISN 0436          NCON2=NCON/4
ISN 0437          NCON3=NCON-NCON/4
ISN 0438          NCON3=NCON3+1
ISN 0439          NCON4=NCON/4+1
ISN 0440          NCON5=NCON-NCON/4
ISN 0441          WRITE(6,1051)(PHMAP(IPRT),IPRT=NCON3,NCON),(PHMAP(IPRT),IPRT=1,NCO
                 *N2)
ISN 0442          DO 1052 ITH=1,NCON
ISN 0443          WRITE(6,1053)THMAP(ITH),(NUMAP(ITH,IPH),IPH=NCON3,NCON),(NUMAP(ITH
                 *,IPH),IPH=1,NCON2)
ISN 0444     1052 CONTINUE
ISN 0445          WRITE(6,1051)(PHMAP(IPRT),IPRT=NCON4,NCON5)
ISN 0446          DO 1054 ITH=1,NCON
ISN 0447          WRITE(6,1053)THMAP(ITH),(NUMAP(ITH,IPH),IPH=NCON4,NCON5)
ISN 0448     1054 CONTINUE
ISN 0449          WRITE(6,1065)
ISN 0450          WRITE(6,1051)(PHMAP(IPRT),IPRT=NCON3,NCON),(PHMAP(IPRT),IPRT=1,NC
                 *ON2)
ISN 0451          DO 1066 ITH=1,NCON
ISN 0452          WRITE(6,1053)THMAP(ITH),(LOSNUM(ITH,IPH),IPH=NCON3,NCON),(LOSNUM(
                 *ITH,IPH),IPH=1,NCON2)
ISN 0453     1066 CONTINUE
ISN 0454          WRITE(6,1051)(PHMAP(IPRT),IPRT=NCON4,NCON5)
ISN 0455          DO 1067 ITH=1,NCON
ISN 0456          WRITE(6,1053)THMAP(ITH),(LOSNUM(ITH,IPRT),IPRT=NCON4,NCON5)
ISN 0457     1067 CONTINUE
ISN 0458     1065 FORMAT(1H0,'MAP OF PHOTONS LOST PRIOR TO SMAPLING'/)
ISN 0459          DO 1057 ISUN=1,NSOL
ISN 0460          THSUN=ARCOS(WS(ISUN))*180./PI
```

```
ISN 0462            WRITE(6,1051)(PHMAP(IPRT),IPRT=NCCN3,NCCN),(PHMAP(IPRT),IPRT=1,NCO
                   *N2)
ISN 0463            DO 1060 ITH=1,NCON
ISN 0464            WRITE(6,1055)THMAP(ITH),(CONMAP(ITH,IPRT,ISUN),IPRT=NCON3,NCON),(C
                   *CNMAP(ITH,IPRT,ISUN),IPRT=1,NCCN2)
ISN 0465       1060 CONTINUE
ISN 0466            WRITE(6,1051)(PHMAP(IPRT),IPRT=NCCN4,NCCN5)
ISN 0467            DO 1062 ITH=1,NCON
ISN 0468            WRITE(6,1055)THMAP(ITH),(CCNMAP(ITH,IPRT,ISUN),IPRT=NCCN4,NCONS)
ISN 0469       1062 CONTINUE
ISN 0470       1057 CONTINUE
ISN 0471       1050 FORMAT(1H0,10X,'MAP STUDY OF CONTRIBUTIONS'/1H0,30X,'NUMBER OF PHO
                   *TONS IN EACH DELTA THETA/DELTA PHI BIN')
```

PAGE 012

```
ISN 0472       1051 FORMAT(1H0,4X,'*'/1H ,'THETA* PHI ',10G11.4/1H ,6X,'*')
ISN 0473       1053 FORMAT(1H0,G11.4,10(I5,6X))
ISN 0474       1055 FORMAT(1H0,11G11.4)
ISN 0475       1058 FORMAT(1H0,'INTENSITIES ACCORDING TO ANGULAR BINS FOR SOLAR ZENITH
                   * ANGLE = ',F5.3)
ISN 0476        500 CONTINUE
ISN 0477        502 CONTINUE
ISN 0478            IF(ISTOP.LE.ITLIM)WRITE(6,673)(MSCA,NUMSCA(MSCA),MSCA=1,NSCA)
                C
                C   WE HAVE FINISHED WITH THE LONGER WAVELENGTH OF OUR LINE PAIR
                C
                C   NOW NORMALIZE SAMPLE MATRIX
                C
ISN 0480            ITKTMP=ITKTM/100
ISN 0481            ISMTMP=ISMTM/100
ISN 0482            WRITE(6,700)ITIME,ITLIM,ISTOP,ITKTMP,ISMTMP
ISN 0483        700 FORMAT(1H0,120(1H*)/1H0,'TOTAL COMPUTATIONAL TIME AVAILABLE = ',
                   1I5,' SEC'/1H0,'PANIC STOP TIME LIMIT WAS ',I5,' SEC'/
                   11H0,'TIME REMAINING AT STOP WAS ',I5,' SEC'/
                   11H0,'TIME SPENT IN TRACKING WAS ',I5,' SEC'/
                   11H0,'TIME SPENT IN SAMPLING WAS ',I5,' SEC'/1H0,120(1H*))
ISN 0484        970 CONTINUE
ISN 0485            IF(ISTOP.LE.ITLIM)FACT=FACT*FLOAT(NMAX)/FLOAT(NGPH)
ISN 0487            XMX=1.
ISN 0488            IF(ISTOP.LE.ITLIM)XMX=ADEN/FLOAT(NCPH)
ISN 0490            WRITE(6,701)NCPH,NMAX
ISN 0491        701 FORMAT(1H0,'NUMBER OF PHOTONS ACTUALLY TRACKED = ',I6/
                   11H ,'(NMAX = ',I5,')')
ISN 0492            IST=0
ISN 0493            CALL OUTPUT(VSAMP2,IND,FACT)
ISN 0494            XMC=FLOAT(NMAX)/FLOAT(NCLUMP)
ISN 0495            IF(ISTOP.LE.ITLIM)XMC=FLOAT(NCPH)/FLOAT(NCLUMP)
ISN 0497            IFL=1
ISN 0498            IF(INFLUX.EQ.0)IFL=2
ISN 0500            CALL TAB(VSAMP2,VSAMP3,XMC,XMX,IND,IFL)
ISN 0501            IF(ISTOP.LE.ITLIM)STOP
ISN 0503            GO TO 1
ISN 0504            END
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

PAGE 013

```
SYMBOL   INTERNAL STATEMENT NUMBERS
I        0062  0064  0065  0066  0103  0104  0283  0283  0290  0405  0420
J        0061  0064  0065  0066  0214  0215  0216  0225  0226  0227  0228
K        0062  0064  0065  0066
L        0063  0064  0065  0066
N        0021  0353
X        0005  0012
CB       0147  0174  0177  0186  0190  0207  0210  0365  0373  0382
CG       0024  0295  0314
CP       0176  0189  0210  0371  0373
DX       0120
HR       0130
IJ       0123  0124  0124  0131  0132  0132  0135  0136  0136  0139  0140  0140  0211  0212  0212  0239  0240  0241  0241
         0242  0246  0247  0248  0248  0249
IX       0050  0052  0052  0066  0114  0115  0116  0117  0146  0149  0150  0151  0285  0332  0333  0363  0364  0366  0367
         0376  0377  0378  0379
IY       0114  0115  0116  0117  0148  0149  0150  0151  0332  0333  0363  0364  0366  0367  0376  0377  0378  0379
I1       0396  0399  0399  0399  0399  0399  0399  0399  0399  0402  0402  0402  0402  0402  0405  0405  0405  0405  0411
         0411  0411  0412  0412  0412  0412  0414  0416
I2       0397  0398  0399  0399  0399  0399  0399  0402  0402  0402  0402  0402  0405  0405  0405  0405  0411  0411  0411
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
         0412  0412  0412  0412  0415  0418
I3       0409  0411  0411  0411  0412  0412  0412  0412  0416  0418
I5       0410  0411  0411  0411  0412  0412  0412  0412  0417  0418
JJ       0019  0215  0229  0331  0341  0343  0346
JK       0021  0336  0345  0346  0363
KK       0059  0070  0072  0083  0087  0094  0096  0261  0261  0356  0399  0399  0399  0399  0399  0399  0399  0399  0402
         0412  0402  0402  0402  0411  0411  0411  0412  0412  0412  0412  0418
NK       0022  0393
NM       0022
PI       0031  0041  0042  0089  0158  0256  0392  0460
SD       0173  0177  0185  0190  0210  0370  0373
SP       0175  0138  0210  0372  0373
UN       0019  0142  0290
US       0018
VN       0019  0143  0290
VS       0018
WN       0019  0144  0290
WS       0018  0460
WW       0341  0342  0343
XH       0020  0216
XX       0332  0334  0340  0340  0343  0343  0346  0363  0365  0366  0368
X1       0009  0012
X2       0112  0114  0119
Y1       0009  0012
Y2       0113  0116  0120
AC1      0023  0344
AC2      0023  0345
AC3      0023  0346
ALD      0024  0265  0319  0319
CDF      0026  0312  0341  0343  0346
CHT      0020  0128  0137  0141  0216
CIN      0019  0118  0119  0120  0124  0132  0136  0140  0210  0212  0216  0220  0241  0248  0252  0373  0380
COS      0174  0176  0189  0369  0371
CZO      0030
ETA      0032
EXP      0256
ICL      0231  0232  0234  0234  0234  0242  0243
IFL      0497  0498  0500
IJ3      0240  0242  0247  0249
IMN      0260  0263
IMP      0013  0268  0268  0269  0271
IMX      0261  0263
INC      0029  0336
IND      0022  0054  0055  0310  0310  0493  0500
IOV      0401  0403  0404  0405  0405
IPH      0443  0443  0443  0443  0443  0443  0447  0447  0447  0452  0452  0452  0452  0452  0452
IPR      0292  0292  0292  0293  0293  0293  0294  0294  0294  0295  0295  0295
ISN      0080  0081
IST      0022  0054  0492
ITH      0074  0075  0076  0078  0079  0081  0090  0091  0091  0092  0092  0442  0443  0443  0443  0446  0447  0447  0451
         0452  0452  0452  0455  0456  0456  0463  0464  0464  0464  0467  0468  0468
JIM      0210  0373
JJK      0344  0345
JTH      0077  0078  0079  0081
MOD      0099  0174
PHI      0157  0161  0175  0176  0187  0188  0189  0191  0368  0371  0372
SIN      0173  0175  0184  0188  0370  0372
SZO      0030
S11      0009  0012
S12      0009  0012
```


*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

```
SYMBOL   INTERNAL STATEMENT NUMBERS
S22      0009  0012
S33      0009  0012
S34      0009  0012
S44      0009  0012
TAU      0030
TOL      0020  0329  0331
TOR      0020
TPI      0031  0042  0157  0187  0209  0368
UNR      0030  0142
VNR      0030  0143
VSA      0008
WAV      0022  0054
WNR      0030  0144
XMC      0494  0495  0500
```

```
XMAX  0467 0465 0500
XPH   0376 0390
XTH   0145 0148 0156 0165 0165 0185 0186 0378 0380
ACLD  0029 0337
ADEN  0025 0162 0256 0486
BETA  0365 0369 0370 0382
CINR  0030 0124 0140 0234 0234 0234
COUT  0017 0210 0212 0373 0380 0382
CREC  0030 0165 0186 0235 0235
DPFC  0089 0091
DTFC  0088 0092
FACT  0043 0485 0485 0493
IALB  0059 0064 0065 0066 0260 0261 0261 0264 0265 0317 0318 0319 0319
ICON  0163 0164 0165 0193 0194 0195
IFC1  0030 0118 0118
IFC2  0030 0119 0119 0121
IFC3  0030 0120 0120 0121
IGND  0021 0229 0290 0313 0313 0405
IMAP  0049 0162 0180 0192 0304 0389 0433
IMCD  0099 0130 0130 0104 0394
IMPJ  0013 0095 0271
IMPX  0013 0268 0269 0271
INCC  0133 0134 0243 0244
IOUT  0277 0285 0290 0304 0306
IPFC  0168 0172 0172 0199 0204 0204 0304 0304 0392 0392
IPRT  0441 0441 0441 0441 0441 0441 0445 0445 0445 0450 0450 0450 0450 0450 0450 0454 0454 0454 0456
      0456 0456 0462 0462 0462 0462 0462 0462 0464 0464 0464 0464 0464 0464 0466 0466 0466 0468 0468
      0468
IOUV  0067 0070 0072
IREC  0030 0096 0125
ISCA  0084 0085 0267 0269 0271 0273 0275 0291 0304 0312 0321 0359
ISKY  0084 0087
ISM1  0355 0358
ISM2  0357 0358
ISUN  0068 0070 0072 0230 0234 0234 0234 0242 0249 0261 0261 0391 0392 0392 0392 0392 0459 0460 0464
      0464 0466
ITHC  0164 0172 0172 0194 0204 0204 0304 0304 0392 0392
ITK1  0279 0287
ITK2  0286 0287
JCCN  0167 0168 0169 0198 0199 0200
JSUN  0071 0072 0398 0399 0399 0399 0399 0399
KMAX  0022 0344
MSCA  0263 0312 0359 0385 0387 0387 0405 0425 0425 0425 0425 0428 0429 0429 0478 0478 0478 0478
MTOT  0427 0429 0429 0430 0431
NALJ  0024 0260 0264 0317 0410 0417
NCON  0033 0147 0388 0389 0390 0153 0167 0193 0198 0436 0437 0437 0439 0440 0440 0441 0442 0443 0446
      0450 0451 0452 0455 0462 0463 0464 0467
NMAX  0022 0099 0100 0100 0102 0103 0430 0485 0490 0494
NOPH  0420 0485 0488 0490 0495
NSCA  0022 0267 0425 0428 0478
NSCL  0018 0230 0391 0397 0415 0459
NUMK  0022
PHIN  0161 0169 0191 0200
PSUN  0002
SDWT  0107 0121 0122 0158 0158 0177 0177 0205 0206 0207 0207 0223
SDTH  0013
SOUT  0019 0226 0228
SORT  0093 0185
SREC  0164 0185
TAUJ  0040 0253 0254 0254 0256
TCLD  0326 0327 0329 0332
THIN  0160 0165 0190 0199
TIME  0279 0286 0355 0357
```


*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

```
SYMBOL  INTERNAL STATEMENT NUMBERS
TORT  0020
TSUN  0072
WSUN  0018 0234 0234 0234 0242 0249
WTEF  0350 0351
WTIN  0224 0350
XPHI  0146 0150 0157 0187
ALBPT 0318 0319
ARCJS 0460
ATAN2 0150
AVSCA 0430 0431
```

```
CLURD     0028  0130  0248  0249  0293
COSAN     0234  0235  0251  0256  0257
DIRAT     0108  0122  0259
DSAMP     0256  0257  0257  0259  0259  0261
DSUNP     0022
DSUNT     0022
FACTR     0030  0118
FLOAT     0088  0089  0091  0092  0102  0430  0430  0485  0485  0488  0494  0494  0495  0495
IAPAT     0033  0039  0392  0392
IIREC     0032  0094  0096
INCLU     0019  0109  0127  0130  0232  0232  0237  0244  0290  0327  0327  0336  0337
INDIC     0021
INPUT     0287
ICNUF     0266
IOTIM     0035  0419
IRAND     0017  0086
IRCLU     0030  0096  0110  0118  0119  0120  0121  0121  0127  0128  0134  0152
IRCOD     0024  0314  0315  0380
ISCAT     0034  0278  0285  0290  0295  0308  0321  0323  0360
ISMFM     0037  0358  0358  0461
ISTOP     0419  0421  0478  0482  0485  0488  0495  0501
ITEST     0015  0282  0283  0288
ITIME     0035  0482
ITKTM     0036  0287  0297  0480
ITLIM     0038  0421  0478  0482  0485  0488  0495  0501
IUPCN     0219  0220  0273  0275  0321  0356
NCLD1     0027  0231
NCON2     0436  0441  0443  0450  0452  0462  0464
NCON3     0437  0438  0436  0441  0443  0450  0452  0462  0464
NCON4     0439  0445  0447  0454  0456  0466  0468
NCON5     0440  0445  0447  0454  0456  0466  0468
NUMAP     0024  0079  0172  0172  0204  0204  0443  0443  0447
PHMAP     0024  0075  0091  0169  0200  0441  0441  0445  0450  0450  0454  0462  0462  0466
RANDU     0114  0116  0148  0150  0332  0363  0366  0376  0378
RECTH     0154  0156  0156
RENEA     0382
RMSTH     0093
SCOPY     0009
SIGCL     0330
THEAR     0014
THETA     0155  0160  0173  0174
THMAP     0024  0076  0092  0165  0195  0443  0447  0452  0456  0464  0468
THSDR     0013  0393
THSUN     0400  0401
TRACK     0285
TRANS     0134  0244
VSAMP     0018  0366  0261  0261  0356  0392  0392  0395  0399  0399  0399  0399  0399  0402  0402  0402  0405  0405  0405
          0411  0412  0412  0418
ALBEDO    0318
ANGLCM    0365
CLCORD    0028  0132  0241  0242  0294
CCNMAP    0024  0381  0392  0392  0464  0464  0468
ECLUMP    0106  0411
FACTOR    0022
FCLUMP    0105  0411
GNDREF    0260
INFLUX    0030  0254  0257  0257  0273  0275  0321  0498
ISMTMP    0481  0482
ITKTMP    0480  0482
LCSNUM    0033  0378  0304  0304  0452  0452  0456
NCLOUD    0027
NCLUMP    0048  0059  0100  0104  0494  0495
NLAYER    0020  0214
NUMSCA    0010  0385  0387  0387  0425  0429  0478
OUTPUT    1453
OVERFL    0401  0404
```


*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

```
SYMBOL    INTERNAL STATEMENT NUMBERS
POINTR    0030
RECANG    0030  0088  0154  0160  0162  0184
REFLOC    0014
REMTIM    0035  0419
SAMPLE    0356
SEESOL    0253
SIGATM    0331  0334  0340
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
SIGTOT   0329   0330   0331
SOLDIR   0011
TAWJON   0013
TOLCLS   0029   0327
VSAMP2   0008   0064   0411   0411   0493   0506
VSAMP3   0008   0065   0412   0412   0500
VSAMP4   0016   0072   0399   0399
VSAMP5   0016   0070   0402   0402
WEIGHT   0026   0222   0223   0223   0224   0290   0337   0337   0342   0342   0350
```



```
LABEL   DEFINED   REFERENCES
   1    0094      0003
  20    0424      0133
  21    0226      0225
  22    0383      0207
  23    0348      0344
  24    0349      0338   0346
  25    0354      0323
  30    0384      0306   0310   0351
  31    0388      0385
  40    0085      0084
  50    0165      0163
  51    0167      0165
  52    0169      0167
  53    0171      0169
  54    0392      0391
  55    0082      0074   0077   0080
  56    0092      0090
  57    0393      0389
  60    0265      0264
  61    0319      0317
  62    0320      0315
  64    0197      0193
  65    0198      0195
  66    0202      0198
  67    0203      0200
  70    0198
  71    0155
  75    0159
 100    0057      0054
 102    0051      0050
 111    0066      0059   0060   0061   0062
 112    0073      0067   0068   0069   0071
 200    0413      0396   0397   0409   0410
 201    0423      0394
 202    0400      0398
 203    0408
 204    0418      0414   0415   0416   0417
 211    0228      0227
 310    0328      0308
 400    0381      0374
 401    0375      0369
 403    0362
 410    0118
 411    0339      0334
 412    0130      0125
 413    0136      0135
 414    0132      0131
 419    0124      0123
 420    0139      0110
 421    0142      0129   0138
 422    0143      0139
 423    0212      0211
 424    0213      0162
 425    0216      0214
 426    0218      0216
 427    0179      0182
 428    0209      0178
 500    0476      0433
 502    0477      0421
 551    0262      0230   0235   0251
 552    0246      0237
 553    0242      0239
 554    0250      0245
 555    0249      0246
 556    0261      0260
 570    0484
 600    0303      0288
```

601	0258	0290	
602	0259	0292	
603	0300	0293	
604	0301	0294	
605	0302	0295	
606	0297	0291	
670	0426	0425	0478
671	0429	0428	
672	0433	0431	
700	0483	0482	
701	0491	0490	
999	0407	0405	

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

LABEL	DEFINED	REFERENCES				
1050	0471	0435				
1051	0472	0441	0445	0450	0454	0462	0466
1052	0444	0442				
1053	0473	0443	0447	0452	0456	
1054	0448	0446				
1055	0474	0464	0468			
1057	0470	0459				
1056	0475	0461				
1060	0465	0463				
1062	0469	0467				
1065	0458	0449				
1066	0453	0451				
1067	0457	0455				

/ MAIN / SIZE OF PROGRAM 012952 HEXADECIMAL BYTES

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
I	SFA	I*4	00067C	J	SF	I*4	000680	K	SF	I*4	000684	L	SF	I*4	000688
N	S C	I*4	0000C0	X	C	R*4	N.R.	CB	SFA	R*4	00068C	CG	SFA C	R*4	0000CC
CP	SFA	R*4	000690	DX	C	R*4	N.R.	FR	C	R*4	N.R.	IJ	SF	I*4	000694
IX	SFA	I*4	000698	IY	SFA	I*4	00069C	I1	SF	I*4	0006A0	I2	SF	I*4	0006A4
I3	SF	I*4	0006A8	I5	SF	I*4	0006AC	JJ	SF C	I*4	000024	JK	SF C	I*4	000018
KK	SFA	I*4	0006B0	NK	F C	I*4	000008	NM	C	I*4	N.R.	PI	SF C	R*4	000000
SB	SFA	R*4	0006B4	SP	SFA	R*4	0006B8	UN	SF C	R*4	000018	CS	C	R*4	N.R.
VN	SF C	R*4	00001C	VS	C	R*4	N.R.	WN	SF C	R*4	000020	WS	FA C	R*4	000838
WA	SF	R*4	0006BC	XH	C	R*4	000484	XX	SFA	R*4	0006C0	X1	C	R*4	N.R.
X2	SFA	R*4	0006C4	Y1	C	R*4	N.R.	Y2	SFA	R*4	0006C8	AC1	S C	R*4	000000
AC2	S C	R*4	000004	AC3	S C	R*4	000008	ALB	SF C	R*4	000004	CDF	F C	R*4	0C6060
CHI	S C	R*4	00005C	CIN	SFA C	R*4	0000C0	C20	C	R*4	N.R.	ETA		R*4	N.R.
ICL	SF	I*4	0006CC	IFL	SFA	I*4	0006D0	IJ3	SF	I*4	0006D4	IMN	S	I*4	0006D8
IMP	SF C	I*4	000000	IMX	S	I*4	0006DC	INC	F C	I*4	0000C0	IND	SFA C	I*4	0000C0
IOV	SFA	I*4	0006E0	IPH	F	I*4	0006E4	IPR	F	I*4	0006E8	ISN	SF	I*4	0006EC
IST	S C	I*4	000034	ITH	SFA	I*4	0006F0	JIM	SF XF	I*4	000000	JJK	SF	I*4	0006F4
JTH	SF	I*4	0006F8	PHI	SFA	R*4	0006FC	S20	C	R*4	N.R.	S11	C	R*4	N.R.
S12	C	R*4	N.R.	S22	C	R*4	N.R.	S33	C	R*4	N.R.	S34	C	R*4	N.R.
S44	C	R*4	N.R.	TAB	SF XF	R*4	000000	TUL	F C	R*4	000324	TCR	C	R*4	N.R.
TPI	SF C	R*4	000004	UNR	F C	R*4	00003C	VNR	F C	R*4	000040	VSA		R*4	N.R.
WAV	S C	R*4	000038	WNR	F C	R*4	000044	XMC	SFA	R*4	000700	XMX	SFA	R*4	000704
XPH	SFA	R*4	000708	XIH	SFA	R*4	00070C	ACLD	F C	R*4	000050	ADEN	SF C	R*4	000000
BETA	SFA	R*4	000710	CINA	F C	R*4	000024	COUT	SFA	R*4	000810	CREC	FA C	R*4	00000C
DPHC	SF	R*4	000714	DTHC	SF	R*4	000718	FACT	SFA	R*4	00071C	IALB	SFA	I*4	000720
ICON	SF	I*4	000724	IFC1	F C	I*4	000018	IFC2	F C	I*4	00001C	IFC3	F C	I*4	000020
IEND	SF C	I*4	00001C	IMAP	S	I*4	000728	IMOD	SF	I*4	00072C	IMPJ	S C	I*4	000008
IMPX	S C	I*4	000004	INDC	SFA	I*4	000730	IOUT	SFA	I*4	000734	IPHC	SF	I*4	000738
IPRT	F	I*4	00073C	IOUV	SF	I*4	000740	IREC	F C	I*4	000004	ISCA	SF	I*4	000744
ISKY	SFA	I*4	000748	ISM1	SFA	I*4	00074C	ISM2	SFA	I*4	000750	ISUN	SFA	I*4	000754
ITHC	SF	I*4	000758	ITK1	SFA	I*4	00075C	ITK2	SFA	I*4	000760	JCON	SF	I*4	000764
JSUN	SF	I*4	000768	KMAX	F C	I*4	000030	MSCA	SF	I*4	00076C	MTCT	SFA	I*4	000770
NALB	F C	I*4	000000	NCON	SFA C	I*4	000000	NMAX	SFA C	I*4	000044	NOPH	SFA	I*4	000774
NSCA	F C	I*4	000004	NSOL	F C	I*4	000000	NUMK	C	I*4	N.R.	PHIN	S	R*4	000778
PSUN		R*4	N.R.	SSWT	SF	R*4	00077C	SDTH	C	R*4	N.R.	SCLT	S C	R*4	000028
SREC	SF	R*4	000780	TAUS	SFA	R*4	000784	TCLD	SF	R*4	000788	THIN	S	R*4	00078C
TIME	SF XF	R*4	000000	TORT	C	R*4	N.R.	TSUN		R*4	N.R.	WSUN	F C	R*4	000004
WIEF	S	R*4	000790	WTIN	SF	R*4	000794	XPHI	SFA	R*4	000798	ALBPT	SFA	R*4	00079C
AVSCA	SF	R*4	0007A0	CLOUD	F C	R*4	000008	COORD	SF C	R*4	000000	CCSAN	SF	R*4	0007A4
CIRAT	SF	R*4	0007A8	DSAXP	SF	R*4	0007AC	DSUNP		R*4	N.R.	DSUNT		R*4	N.R.
FACTR	F C	R*4	000048	IAPAT	SF C	I*4	000004	IIREC	S C	I*4	000000	INCLD	SFA C	I*4	000068
INCIC	C	I*4	N.R.	INPUT	SF XF	I*4	000000	ICNOF	S	I*4	000780	ICTIM	SFA	I*4	0007B4
IRAND	S C	I*4	000000	IRCLD	SFA C	I*4	000000	IRCOD	SFA C	I*4	000004	ISCAT	SFA C	I*4	000000
ISWIM	SF	I*4	0007B8	ISTOP	SFA	I*4	0007BC	ITEST	S C	I*4	000000	ITIME	SFA	I*4	0007C0

```
     ITKIM  SF        I*4  0007C4      ITLIM  SF        I*4  0007C8      IOPEN  SFA       I*4  0007CC      NCLDT  F      C  I*4  000004
     NCON2  SF        I*4  0007DC      NCON3  SF        I*4  0007D4      NCON4  SF        I*4  0007D8      NCON5  SF        I*4  0007DC
     NUMAP  SF        I*4  000E28      PHMAP  SF        R*4  000E68      RANDU  SF    XF  R*4  000000      RECTH  SF        R*4  0007E0
     RENEW  SF    XF  R*4  000000      RMSTH  S         R*4  0007E4      SCOPY            R*4    N.R.      SIGCL  S         R*4  0007E8
     THEAR         C  R*4    N.R.      THETA  SFA       R*4  0007EC      THMAP  SF        R*4  000E98      THSER  FA     C  R*4  000010
     THSUN  SF        R*4  0007F0      TRACK  SF    XF  R*4  000000      TRANS  SF    XF  R*4  000000      VSAMP  SFA       R*4  000FC8
     ARCOS        XF  R*4  000000        EXP        XF  R*4  000000      ATAN2        XF  R*4  000000        CCS        XF  R*4  000000
       SIN        XF  R*4  000000       SQRT        XF  R*4  000000      ALBEDO SF    XF  R*4  000000      ANGLEM SF    XF  R*4  000000
     CLCORD SF     C  R*4  000018      CONMAP SF        R*4  003DEC      ECLUMP SF        R*4  0007F4      FACTOR        C  R*4    N.R.
     FCLUMP SF        R*4  0007F8      GNOREF SF    XF  R*4  000000      IECOM# F     XF  I*4  000000      INFLUX S      C  I*4  000054
     ISWTMP SF        I*4  0007FC      ITKTMP SF        I*4  000500      LOSNUM SF        I*4  009BAC      NCLCUD        C  I*4    N.R.
     NCLUMP SFA       I*4  000804      NLAYER F      C  I*4  000000      NUMSCA SF        I*4  00A1EC      OUTPUT SF    XF  R*4  000000
     OVERFL SF    XF  R*4  000000      POINTR        C  R*4    N.R.      RECANG FA     C  R*4  000008      REFLCC SF    XF  R*4  000000
     RENTIM SF    XF  R*4  000000      SAMPLE SF    XF  R*4  000000      SEESOL SF    XF  R*4  000000      SIGATM SF        R*4  000808
     SIGTOT SF        R*4  000800      SOLDIR           R*4    N.R.      TAWSUN        C  R*4    N.R.      TOLCLD F      C  R*4  000028
     VSAMP2 SFA       R*4  00A500      VSAMP3 SFA       R*4  00D3EC      VSAMP4 SF     C  R*4  000000      VSAMP5 SF     C  R*4  001C20
     WEIGHT SF     C  R*4  000000

                                   *****  COMMON INFORMATION   *****

          NAME OF COMMON BLOCK  *       *  SIZE OF BLOCK   007530 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.
            S11   R*4     N.R.           S12   R*4     N.R.           S22   R*4     N.R.           S33   R*4     N.R.
            S34   R*4     N.R.           S44   R*4     N.R.             X   R*4     N.R.            X1   R*4     N.R.
             Y1   R*4     N.R.           CDF   R*4   006D60

          NAME OF COMMON BLOCK  *IMPCRT*   SIZE OF BLOCK   000018 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.
            IMP   I*4   000000          IMPX   I*4   000004          IMPJ   I*4   000008        TAWSUN   R*4     N.R.
          THSBR   R*4   000010          SOTH   R*4     N.R.

                                                                                                            PAGE 020

          NAME OF COMMON BLOCK  *SPTLIT*   SIZE OF BLOCK   000004 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.
          THEAR   R*4     N.R.

          NAME OF COMMON BLOCK  *   TST*   SIZE OF BLOCK   000004 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.
          ITEST   I*4   000000

          NAME OF COMMON BLOCK  *  CTAB*   SIZE OF BLOCK   001E0C HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.
         VSAMP4   R*4   000000        VSAMP5   R*4   001C20

          NAME OF COMMON BLOCK  *SCROLL*   SIZE OF BLOCK   000004 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.
          IRAND   I*4   000000

          NAME OF COMMON BLOCK  *   SOL*   SIZE OF BLOCK   000874 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.
           NSOL   I*4   000000          *SUN   R*4   000004            US   R*4     N.R.            VS   R*4     N.R.
             *S   R*4   000838

          NAME OF COMMON BLOCK  *  PHOT*   SIZE OF BLOCK   00006C HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.
            CIN   R*4   000000            UN   R*4   000018            VN   R*4   00001C            WN   R*4   000020
             JJ   I*4   000024          SOUT   R*4   000028         INCLD   I*4   000068

          NAME OF COMMON BLOCK  *   ATM*   SIZE OF BLOCK   000704 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.  VAR. NAME  TYPE  REL. ADDR.
```

```
     NLAYER     I*4    000000           TCR     R*4     N.R.           TURT     R*4     N.R.           TCL     R*4    000324
         XH     R*4    0004B4            DX     R*4     N.R.

                NAME OF COMMON BLOCK  * SEAT*   SIZE OF BLOCK     000020 HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
       N        I*4    000000         INDIC    I*4     N.R.            JK     I*4    000018           IGND     I*4    00001C

                NAME OF COMMON BLOCK  * PARAM*  SIZE OF BLOCK     000048 HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
       IND      I*4    000000          NSCA    I*4    000004            NK     I*4    000008           NUMK     I*4     N.R.
      KMAX      I*4    000030           IST    I*4    000034           WAV     R*4    000038         FACTOR     R*4     N.R.
        NM      I*4     N.R.           NMAX    I*4    000044

                NAME OF COMMON BLOCK  *   ACC*  SIZE OF BLOCK     00000C HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
       AC1      R*4    000000           AC2    R*4    000004           AC3     R*4    000008

                NAME OF COMMON BLOCK  *   GND*  SIZE OF BLOCK     000004 HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
      NALB      I*4    000000           ALB    R*4    000004            CG     R*4    0000CC

                NAME OF COMMON BLOCK  *   FIL*  SIZE OF BLOCK     000004 HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
      ACEN      R*4    000000

                NAME OF COMMON BLOCK  *    *T*  SIZE OF BLOCK     000004 HEXADECIMAL BYTES

                                                                                                              PAGE 021
   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
     *EIGHT     R*4    000000

                NAME OF COMMON BLOCK  * CLPAR*  SIZE OF BLOCK     000198 HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
    NCLCUD      I*4     N.R.          NCLD1    I*4    000004         CLOUD     R*4    000038

                NAME OF COMMON BLOCK  *CRDNTE*  SIZE OF BLOCK     000030 HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
     CCCRD      R*4    000000         CLCCRD   R*4    000018

                NAME OF COMMON BLOCK  *CLDATM*  SIZE OF BLOCK     000078 HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
       INC      I*4    000000        TOLCLD    R*4    000028          ACLD     R*4    000050

                NAME OF COMMON BLOCK  *  RCVR*  SIZE OF BLOCK     00005C HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
     IRCLD      I*4    000000          IREC    I*4    000004        RECANG     R*4    000008           CREC     R*4    00000C
        HR      R*4     N.R.            AZ0    R*4     N.R.           IFC1     I*4    000018           IFC2     I*4    00001C
      IFC3      I*4    000020          CINR    R*4    000024           UNR     R*4    00003C            VNR     R*4    000040
       *NR      R*4    000044         FACTR    R*4    000048        PCINTR     R*4     N.R.            CHT     R*4    000050
    INFLUX      I*4    000054           S20    R*4     N.R.

                NAME OF COMMON BLOCK  * CONST*  SIZE OF BLOCK     000008 HEXADECIMAL BYTES

   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.   VAR. NAME   TYPE  REL. ADDR.
        PI      R*4    000000           TPI    R*4    000004
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
        NAME OF COMMON BLOCK  * INPUT*    SIZE OF BLOCK     000008 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
         IIREC     I*4   000000

        NAME OF COMMON BLOCK  *MAPCOM*    SIZE OF BLOCK     000008 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
         NCCN      I*4   000000         IAPAT     I*4   000004

        NAME OF COMMON BLOCK  *GNCHIT*    SIZE OF BLOCK     000008 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
         ISCAT     I*4   000000         IRCCD     I*4   000004

  LABEL    ADDR                  LABEL   ADDR                   LABEL   ADDR                   LABEL   ADDR              PAGE 022

      1    010682                  111   01067E                   112   010722                    55   010708
     40    010826                   56   0108E4                    70   010954                   410   010A42 NR
    419    010AF6                  412   010B36                   414   010B52                   413   010B8E
    420    010B3C                  422   010BEE                   421   010BDC                    71   010C4A NR
     79    010C7A NR                50   010CAA                    51   010CCA                    52   010CFA
     53    010D2A                  427   010D5E                    64   010E06                    65   010EEA
     66    010F26                   67   010F3A                   428   010F8E                   423   010FA8
    424    010F3A                  425   010FDC                   426   010FFA                    21   011048
    211    01106A                  553   011148                   552   011196                   555   0111C6
    554    0111F2                  556   0112CC                   551   0112D2                    60   01132E
    600    01164E                   61   011716                    62   01173C                   310   011782
    411    011834                   23   0118AC                    24   011882                    25   0118EE
    403    01193A                  401   0119EE                   400   011A28                    22   011A36
     30    011A4C                   31   011A72                    54   011ACE                    57   011AF4
    202    0113E8                  203   011C80                   200   011D30                   204   011DBE
    201    011E28                   20   011E26                   071   011E86                  1052   0120CE
   1054    01219E                 1060   0122C2                  1067   012398                  1060   012592
   1062    01264C                 1057   012680                   500   012688                   502   012688
    570    012748 NR

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

*STATISTICS*      SOURCE STATEMENTS =      503 ,PROGRAM SIZE =      76114

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                             49K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                              OS/360  FORTRAN H                              DATE  76.324/21.45.16

              COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                                 SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
      ISN 0002                 SUBROUTINE INPUT(KK,ISKY)
                          C**
                          C**      S U B R O U T I N E    I N P U T
                          C**
                          C
                          C THIS SUBROUTINE READS AND/OR COMPUTES INFORMATION REQUIRED
                          C FOR THE SIMULATION
                          C
      ISN 0003                 INTEGER XCAP(3)
      ISN 0004                 COMPLEX RN(5)
      ISN 0005                 DIMENSION SCALE(5)
      ISN 0006                 DIMENSION INDICA(5)
      ISN 0007                 DIMENSION THINI(100)
      ISN 0008                 DIMENSION XR(100),COF(5,100),CENS(5,100),Y2(100),
                              *                               X(5,100),X1(5,100),Y1(5,100),
                              1S11(100,5),S12(100,5,2),S22(100,5,2),S33(100,5,2),S34(100,5,2),
                              2S44(100,5,2),
                              3IDIST(5),STEP(5),AVEL(3,2),SIGMA(3,2,3),A1(5),B1(5),C1(5),D1(5)
      ISN 0009                 DIMENSION ASECT(5),CSECT(5)
      ISN 0010                 DIMENSION IUNIT(5),NTCT(5)
      ISN 0011                 DIMENSION TCRT(100),U(15),TEMP(100)
      ISN 0012                 DIMENSION DUMMY(100),DUM1(100)
      ISN 0013                 DIMENSION DUM2(100)
      ISN 0014                 DIMENSION SCLDIR(15,3)
      ISN 0015                 DIMENSION SCLSTD(3)
      ISN 0016                 DIMENSION SCLMU(15),SCLPHI(15)
```

```
ISN 0017          DIMENSION OMAX(5),NSTP(5),DELC(5)
ISN 0018          DIMENSION ITAPE(5)
ISN 0019          DIMENSION THSINT(100)
ISN 0020          COMPLEX REFACT
ISN 0021          COMMON S11, S12, S22, S33, S34, S44, X, X1, Y1, CDF
ISN 0022          COMMON/RMAP/IRPAT,IRBGD,IRSFCT,XBND,CNTRX(20),CNTRY(20),EDGEX(20),
                 .EDGEY(20)
ISN 0023          COMMON/FREN/FN,WSIG,WSIG2,ANG(3),ZX,ZY
ISN 0024          COMMON/INPORT/IMP,IMPX,IMPJ,TAWSUN,THSBR,SDTH
ISN 0025          COMMON/SFTLIT/THBAR
ISN 0026          COMMON/SOL/NSOL,WSUN(11,15,3),US(15),VS(15),WS(15)
ISN 0027          COMMON/PHOT/CIN(6),UN,VN,WN,JJ,SCLT(16),INCLD
ISN 0028          COMMON/ATM/NLAYER,TOR(100),TORT(100),TOL(100),XH(100),CX(100)
ISN 0029          COMMON/SCAT/N,INDIC(5),JK,ICND
ISN 0030          COMMON/PARAM/INC,NSCA,NK(5),NOAK(5),KMAX,IST,WAV,FACTOR,NM
                 1,NMAX
ISN 0031          COMMON/GND/NALB,ALB(50),CG(2)
ISN 0032          COMMON/CLEAR/NCLOUD,NCLD1,CLOUD(10,10)
ISN 0033          COMMON/CLDAT/INC(10),TCLCLD(10),ACLD(10)
ISN 0034          COMMON/CREAD/HCL(10),ACL(10),BCL(10),CCL(10),XCL(10),YCL(10),
                 .THDEG(10),CLDEN(10)
ISN 0035          COMMON/RCVR/IRCLD,IREC,RECANG,CREC,FR,C2C,IFC1,IFC2,IFC3,
                 .CINR(6),UNR,VNR,WNR,FACTR,FCINTR,CHT
                 ..INFLUX,S20
ISN 0036          COMMON/CONST/PI,TPI
ISN 0037          COMMON/SCROLL/IRAND
ISN 0038          COMMON/SNORM/SOLC
ISN 0039          COMMON/NAFCOM/NCON,IAPAT
ISN 0040          DATA XCAP/1HX,1HY,1HZ/
ISN 0041          DATA SOLSTO/0.0,30.0,60.0/
ISN 0042       95 FORMAT(F10.6)
ISN 0043       98 FORMAT(F3.0,2X,E9.3)
ISN 0044       99 FORMAT(F3.0,2X,F3.0)
ISN 0045      100 FORMAT(1011,213,16,712,513)
ISN 0046      101 FORMAT(13,4F6.3,11)
ISN 0047      102 FORMAT(5E11.6)
ISN 0048      103 FORMAT(F6.1,6E12.5)
ISN 0049      104 FORMAT(2E11.4)
ISN 0050      105 FORMAT(F3.0,2E9.3,F3.0)
ISN 0051      107 FORMAT(F7.4,F7.2)
ISN 0052      109 FORMAT(1H0//,
                 . 127H  LAYER TOP HEIGHT    OZONE     MOLECULAR      HAZE          AERO
                 .SOL          OTHER             OT       CUMULATIVE OT    TEMP(K)    ABSCRPTION
                 .//
                 .  100(4X,E11.4,3X,9(1X,E11.4)/ ))
ISN 0053      112 FORMAT(1H ,11G11.4)
ISN 0054      113 FORMAT(1H ,24(I5))
ISN 0055      114 FORMAT(I6)
ISN 0056      115 FORMAT(6HOSTEP=,F5.2,6X,3HA1=,E11.4,6X,3HB1=,E11.4,6X,3HC1=,E11.4)
ISN 0057      116 FORMAT(47H1    LAYER TOP HEIGHT      C.T. FROM TOP     ALBEDO,6X,
                 115HSCATTERING O.T.//100(5X,E13.5,6X,E12.5,3X,E12.5,6X,E12.5/))
ISN 0058      117 FORMAT(36H0TOTAL SCATTERING OPTICAL THICKNESS=,F10.5)

ISN 0059      118 FORMAT(1H ,F6.4,6(2X,E11.4))
ISN 0060      119 FORMAT(8H1   ANGLE,8X,3HS11,10X,3HS12,10X,3HS22,10X,3HS33,10X,
                 13HS34,10X,3HS44)
ISN 0061      120 FORMAT(1H+,50X,2HX=,F6.2,6X,3HFF=,E11.4)
ISN 0062      121 FORMAT(34HOTOTAL OZONE IN ATMOSPHERIC MODEL=,F10.5,9H ATM-CMS.)
ISN 0063      123 FORMAT(1H0,22HTHIS SIMULATION TRACKS,I6,8H PHOTONS)
ISN 0064      140 FORMAT(212,6E11.4)
ISN 0065      141 FORMAT(I2)
ISN 0066      143 FORMAT(4E11.4)
            C
            C      MAIN TITLE
ISN 0067      400 FORMAT(1H0,36X,45(1H*)/1H ,35X,3H***,39X,3H***/
                 .1H ,36X,3H***,14X,11HC  T R A N S,14X,3H***/
                 .1H ,36X,3H***,39X,3H***/
                 .1H ,36X,3H***,5X,29HRADIATION TRANSPORT THROUGH A,5X,3H***/
                 .1H ,36X,3H***,7X,22HLAYERED PLANE PARALLEL,10X,3H***/
                 .1H ,36X,3H***,7X,24HATMOSPHERE WITH EMBEDDED,8X,3H***/
                 .1H ,36X,3H***,12X,13HFINITE CLOUDS,14X,3H***/
                 .1H ,36X,3H***,39X,3H***/1H ,36X,45(1H*))
            C
            C      SIMULATION PARAM TITLE
ISN 0068      401 FORMAT(1H0,7(1H*),23X,1H*/1H ,6X,1H*,23H SIMULATION PARAMETERS ,1H
                 .*/1H ,6X,1H*,23X,1H*)
            C
```

```
                 C      RECEIVER TITLE
ISN 0069           402 FORMAT(1H0,7(1H*),22X,1H*/1H ,6X,1H*,22H RECEIVER DESCRIPTION ,1H*
                      */1H ,6X,1H*,22X,1H*)
                 C
                 C      SUN TITLE
ISN 0070           403 FORMAT(1H0,7(1H*),25X,1H*/1H ,6X,1H*,25H SOLAR ARRAY DESCRIPTION ,
                      *1H*/1H ,6X,1H*,25X,1H*)
                 C
                 C      GROUND TITLE
ISN 0071           404 FORMAT(1H0,7(1H*),20X,1H*/1H ,6X,1H*,20H GROUND DESCRIPTION ,1H*/1
                      *H ,6X,1H*,20X,1H*)
                 C
                 C      ATMOSPHERE TITLE
ISN 0072           405 FORMAT(1H0,7(1H*),24X,1H*/1H ,6X,1H*,24H ATMOSPHERE DESCRIPTION ,1
                      *H*/1H ,6X,1H*,24X,1H*)
ISN 0073           420 FORMAT(1H0,17HRECEIVER POSITION/
                      *1H ,21X,11HALTITUDE = ,F8.3/
                      *1H ,17X,15HX-COORDINATE = ,F8.3/
                      *1H ,17X,15HY-COORDINATE = ,F8.3)
ISN 0074           421 FORMAT(1H0,27HRECEIVER POINTING DIRECTION/1H ,5X,34HCOSINE OF RECE
                      *IVER ZENITH ANGLE = ,F7.4/
                      *1H ,7X,'SINE OF RECEIVER ZENITH ANGLE = ',F7.4/
                      *1H ,44HPLANE CONTAINING RECEIVER AND VERTICAL IS AT,F7.2,
                      *16H DEGREES AZIMUTH)
ISN 0075          4210 FORMAT(1H+,70X,'RECEIVER ZENITH ANGLE = ',F9.4,' DEGREES')
ISN 0076          4211 FORMAT(1H+,70X,'RECEIVER NADIR ANGLE = ',F9.4,' DEGREES')
ISN 0077           422 FORMAT(1H0,'AT EACH POINT ON THE RECEIVER, THE FIELD'/
                      *1H ,' OF VIEW IS CONICAL WITH APEX ANGLE = ',E14.7,' RADIANS')
ISN 0078           423 FORMAT(1H0,71HOPTICAL DISTANCE OUT OF ATMOSPHERE ALONG RECEIVER PO
                      *INTING DIRECTION = ,E14.7)
ISN 0079           424 FORMAT(1H0,21HRECEIVER AREA IS THE ,A1,2H =,F8.3,19H FACE OF CLOUD
                      * NO. ,I2)
ISN 0080           425 FORMAT(1H ,32H(RECEIVER POINTS INTO THE CLOUD))
ISN 0081           426 FORMAT(1H ,34H(RECEIVER POINTS OUT OF THE CLOUD))
ISN 0082           427 FORMAT(1H0,15X,'****  POLARIZATION NOT INCLUDED IN COMPUTATION')
ISN 0083           428 FORMAT(1H0,15X,'****  COMPUTATION IS FOR GROUND ALBEDO = 0. ONLY')
ISN 0084           431 FORMAT(1H ,2X,I2,2X,1H(,15X,1H),2X,3(F7.4,5X),E10.4)
ISN 0085           432 FORMAT(1H+,7X,10HDIRECT SUN)
ISN 0086           433 FORMAT(1H+,7X,14HUSER SPECIFIED)
ISN 0087           434 FORMAT(1H+,7X,15HCTRANS STANDARD)
ISN 0088           435 FORMAT(1H0,76HINTENSITY OF INCIDENT SUNLIGHT IS NORMALIZED TO PI O
                      *R TO THE SOLAR CONSTANT = ,F8.4)
ISN 0089           436 FORMAT(1H0,'SOLAR CONSTANT (NORMALIZATION) = ',F10.6)
ISN 0090           430 FORMAT(1H0,27X,27HDIRECTION COSINES OF VECTOR/1H ,27X,29HPOINTING
                      *FROM RECEIVER TO SUN,8X,16HOPTICAL DISTANCE/1H ,7H SUN NO.,20X,1HX,
                      *11X,1HY,11X,1HZ,9X,20HTO SUN FROM RECEIVER)
ISN 0091           441 FORMAT(1H ,58HCALCULATIONS ARE MADE USING THE FOLLOWING GROUND ALB
                      *EDOS/1H ,5(F6.4,5X))
ISN 0092           442 FORMAT(1H0,'COMPUTATIONS ARE TO BE MADE FOR THE FOLLOWING ',I3,
                      *' GROUND ALBEDO PATTERNS'//)
ISN 0093           410 FORMAT(1H ,13HWAVELENGTH = ,F7.4,8H MICRONS)
ISN 0094           411 FORMAT(1H+,31X,8H(DOBSON ,A1,5H LINE))
ISN 0095           412 FORMAT(1H0,28HNUMBER OF PHOTONS TRACKED = ,I6/1H0,43HMAXIMUM NUMBE
                      *R OF SCATTERINGS PER PHOTON = ,I3/1H0,31HNUMBER OF ATMOSPHERIC LAY
                      *ERS = ,I3/1H0,24HINITIAL RANDOM NUMBER = ,I12)
ISN 0096           413 FORMAT(1H0,38HSIMULATION CONTROL CARD WAS AS FOLLOWS/1H ,25(I5))
```



```
ISN 0097           414 FORMAT(1H+,32X,8H(DOBSON ,A1,6H LINE))
ISN 0098           415 FORMAT(1H0,28HOZONE INPUT = NUMBER DENSITY)
ISN 0099           416 FORMAT(1H0,49HOZONE INPUT = MICROMILLIBARS (NOT TEMP CORRECTED))
ISN 0100           417 FORMAT(1H0,52HOZONE INPUT = MICROMILLIBARS (TEMPERATURE CORRECTED)
                      *)
ISN 0101           418 FORMAT(1H0,41HOZONE CROSS SECTIONS ARE FOR DOBSON LINES)
ISN 0102           419 FORMAT(1H0,3 HOZONE CROSS SECTION READ IN = ,E14.7)
ISN 0103           450 FORMAT(1H0,35HTOTAL OZONE IN ATMOSPHERIC MODEL = ,F7.3,9H ATM.CMS.
                      */1H0,'NUMBER OF PLANE PARALLEL LAYERS = ',I3/
                      *1H0,'ATMOSPHERIC CONSTITUANTS')
ISN 0104           451 FORMAT(1H ,97X,22HCROSS SECTIONS (CM**2)/1H ,5X,39HNUMBER OF PARTI
                      *CLE SPECIES REQUESTED = ,I1,53X,10HEXTINCTION,5X,10HABSORPTION)
ISN 0105           452 FORMAT(1H+,95X,E11.4,4X,E11.4)
ISN 0106           453 FORMAT(1H0,3X,1H(,I1,1H),2X,5HOZONE)
ISN 0107           454 FORMAT(1H0,3X,1H(,I1,1H),2X,8HRAYLEIGH)
ISN 0108           455 FORMAT(1H0,3X,1H(,I1,1H),2X,7HAEROSOL)
ISN 0109           461 FORMAT(1H ,14X,29HSCATTERING MATRIX DEFINED AT ,I3, 7H ANGLES)
ISN 0110           456 FORMAT(1H+,20X,35HMONODISPERSE WITH SIZE PARAMETER = ,F10.2)
ISN 0111           457 FORMAT(1H+,20X,16HPOLYDISPERSE WITH ,13X,21HDIAMETER DISTRIBUTION)
ISN 0112           458 FORMAT(1H+,38X,5HJUNGE/1H0,10X,7HDMIN = ,F6.2,8H MICRONS,6X,5HNU =
                      * ,F6.2)
```

```
ISN 0113    459 FORMAT(1H+,38X,9HLOGNORMAL/1HC,1C),8HDELTA = ,F8.3,6X,5HCO = ,F8.3
               *,8H MICRONS,6X,7HOMIN = ,F8.3,8H MICRONS)
ISN 0114    460 FORMAT(1H+,38X,12HDIERMENDJIAN/1HC,10X,8HALPHA = ,F8.4,6X,4HB = ,
               *F8.4,6X,8HGAMMA = ,F8.4)
ISN 0115    462 FORMAT(1H+,11X,41HUSER SPECIFIED SCATTERING MATRIX ELEMENTS)
ISN 0116    463 FORMAT(1H1,33HATMOSPHERIC LAYER CHARACTERISTICS/1H ,5X,23HDENSITIE
               *S ARE IN CM**-3)
ISN 0117    464 FORMAT(1H+,38X,'HAZE C'/1H ,10X,'C1(=CMIN)= ',F8.2,'MICRONS',
               *6X,'A1(=CMIC)= ',F8.2,' MICRONS',5X,'E1(POWER LAW) = ',F6.2)
ISN 0118    465 FORMAT(1H ,20X,'REFRACTIVE INDEX = ',2E14.7)
ISN 0119    466 FORMAT(1H ,20X,'TOTAL VERTICAL OPTICAL THICKNESS OF AMBIENT SPECIE
               *S = ',E14.7)
ISN 0120    467 FORMAT(1H ,10X,'PARTICLE DIAMETER = ',F11.6,' MICRONS')
ISN 0121    468 FORMAT(1H ,10X,'DIAMETER STEP SIZE IN PARTICLE SIZE INTEGRATION =
               *',F11.6,' MICRONS'/1H ,10X,'MAXIMUM DIAMETER IN INTEGRATION = ',F1
               *1.6,' MICRONS'/1H ,10X,'NUMBER OF STEPS IN INTEGRATION = ',I4)
ISN 0122    470 FORMAT(1HC,55HPHOTONS ARE KEPT IN THE ATMOSPHERE BY WEIGHTING (IBO
               *X.NE.0))
ISN 0123    471 FORMAT(1H0,67HPHOTONS ARE NOT DROPPED WHEN OZONE IS ENCOUNTERED. G
               *RAY WEIGHTING IS IN USE (IWAT.NE.0))
ISN 0124    472 FORMAT(1H0,37HTOTAL SCATTERING OPTICAL THICKNESS = ,F1C.6)
ISN 0125    473 FORMAT(1H ,36H(PHOTONS ARE ALLOWED TO ESCAPE AFTER,I2,20HTH ORDER
               *SCATTERING))
ISN 0126    408 FORMAT(1H0,6(1H*),22X,1H*/1H ,5X,24H*  CLOUDS DESCRIPTION   */1H ,
               *5X,1H*,22X,1H*)
ISN 0127    481 FORMAT(1HC,19HNUMBER OF CLOUDS = ,I2)
ISN 0128    482 FORMAT(1HC,12HNO CLOUDS IN SKY)
ISN 0129    483 FORMAT(1HC,7X,8HALTITUDE,73X,7HDENSITY/
               *1H ,10X,2HOF,62X,5HCLOUD,13X,2HOF,5X,7HOPTICAL/
               *1H ,6X,4HBASE,62X,11HATMOSPHERIC,3X,5HCLOUD,4X,4HPATH/
               *1H ,5HCLOUD,5X,2HOF,5X,60HLINEAR DIMENSIONS OF CLOUD  COORDINATES
               *OF CM  ROTATION  CONSTITUENT  PARTICLES LENGTH/
               *1H ,3HNO.,5X,5HCLOUD,3X,1HX,8X,1HY,8X,1HZ,10X,1HX,8X,1HY,6X,5HANGL
               *E,4X,4HCLOUD,9X,5H(CM**-3),2X,7HPER KM.//)
ISN 0130    484 FORMAT(1H ,I2,4X,F8.3,2X,3(F8.3,1X),2X,2(F8.3,1X),1X,F8.3,2X,I2,9X
               *,E10.4,2X,E10.4)
ISN 0131    495 FORMAT(2I2,7E10.4,2I2)
ISN 0132    510 FORMAT(1HC,5X,1H*,38X,1H*/1H ,5X,'*   SCATTERING  PROBABILITY  FUNC
               1TIONS   *'/1H ,5X,1H*,38X,1H*)
ISN 0133    511 FORMAT(1HC,5X,'SPECIES ',I2/1H0,5X,'ANGLE (DEG)',4X,'PROBABILITY'/
               1/)
ISN 0134    512 FORMAT(1H ,2(5X,E10.4))
            C          REFLECTANCE MAP TITLE
ISN 0135    560 FORMAT(1HC,7(1H*),31X,1H*/1H ,6X,'*    REFLECTANCE MAP STRUCTURE
               *'/1H ,6X,1H*,31X,1H*)
ISN 0136    561 FORMAT(1HC,'GROUND')
ISN 0137    562 FORMAT(1H+,7X,'PLANE IS UNIFORMLY ')
ISN 0138    563 FORMAT(1H+,26X,'LAMBERTIAN')
ISN 0139    564 FORMAT(1H+,26X,'ROUGH FRESNEL')
ISN 0140    565 FORMAT(1H+,7X,'HALF-PLANE X.GT. ',G14.7,' KM. IS ')
ISN 0141   5650 FORMAT(1H+,15X,'X.LT. ',G14.7,' KM. IS ')
ISN 0142    566 FORMAT(1H+,46X,'LAMBERTIAN'/1H ,46X,'ROUGH FRESNEL')
ISN 0143    567 FORMAT(1H+,46X,'ROUGH FRESNEL'/1H ,46X,'LAMBERTIAN')
ISN 0144    568 FORMAT(1H+,11X,'BACKGROUND IS')
ISN 0145    569 FORMAT(1HC,12X,'WITH THE FOLLOWING INSET ',15X,'INHOMOGENEITIES OF
               *RECTANGULAR SHAPE')
ISN 0146    570 FORMAT(1H+,36X,'   LAMBERTIAN')
ISN 0147    571 FORMAT(1H+,36X,' ROUGH FRESNEL')
ISN 0148    572 FORMAT(1HC,5X,'C E N T E R',14X,'E D G E  L E N G T H S'/
```



```
               *1H ,2(7X,'X',15X,'Y',6X))
ISN 0149    573 FORMAT(1H ,4(G14.7,2X))
ISN 0150    574 FORMAT(1HC,'ROUGH FRESNEL REGION(S) CHARACTERIZED BY'/
               *1H ,6X,'INDEX OF REFRACTION OF SURFACE = ',F7.4/
               *1H ,6X,'SURFACE ROUGHNESS CHARACTERIZED BY A GAUSSIAN SLOPE DISTRI
               *BUTION WITH'/
               *1H ,12X,'VARIANCE = A0+A1*ASPD = ',G14.7)
ISN 0151    576 FORMAT(1H ,20X,'WHERE    A0 = ',G14.7/
               *1H ,28X,'A1 = ',G14.7/
               *1H ,26X,'ASPD = ',G14.7,' M./SEC.')
ISN 0152    641 FORMAT(1H0,33HSCALE HEIGHT CORRECTED. EXPFAC = ,F10.7)
ISN 0153    650 FORMAT(1H0,'THETA SQUARED BAR = ',F12.4,' DEG**2'/
               *1H ,'RMS THETA = ',F9.4,' DEG')
ISN 0154    651 FORMAT(1H0,'AEROSOL SCATTERING DIRECTIONS WILL BE IMPORTANCE SAMPL
               *ED INTO SOLAR DIRECTION USING A GAUSSIAN WITH VARIANCE = ',F12.4,
               *' DEG**2')
ISN 0155    652 FORMAT(1H0,'***** WARNING -- INF .GE.1 AND INPUT SPECIFIES NSOL= '
               *,I2,' CALCULATION WILL PROCEED WITH NSOL = 1')
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0156      653 FORMAT(1H0,'IF THE FIRST SCATTERING IS BY AN AEROSOL PARTICLE, THE
                 . SCATTERING DIRECTION WILL BE IMPORTANCE SAMPLED INTO THE SOLAR DI
                 .RECTION'/1H ,5X,'SUCCEEDING SCATTERINGS WILL USE S11')
ISN 0157      753 FORMAT(1H0,'SCATTERINGS AFTER THE ',I3,' TH ARE IMPORTANCE FUNCTIO
                 .N DIRECTED (EXPONENTIALLY)'/1H ,5X,' THE SPREAD OF THE EXPONENTIA
                 .L IS ADJUSTED BY THE STD. DEV. OF THE AEROSOL SCAT. ANG. = ',F12.4
                 .)
ISN 0158      850 FORMAT(1H0,'AVERAGE SCATTERING ANGLE = ',F10.4,' DEG.')
ISN 0159          RADCON=PI/180.
ISN 0160          FA=WAV
              C         FACILITY FOR SERIAL INPUT OF SUNS WHEN USING IMPORTANCE SCAT.
ISN 0161          IF(IMP.GE.1.AND.IST.EQ.0)GO TO 300
ISN 0163          IF(IND.EQ.2)GO TO 1022
ISN 0165          IF(IND.EQ.1.AND.KK.EQ.2)GO TO 1020
ISN 0167          IF(IST.EQ.0)GO TO 1021
ISN 0169          THBAR=PI/2.
ISN 0170          DO 10 I=1,5
ISN 0171          DO 10 J=1,100
ISN 0172          CDF(I,J)=0.
ISN 0173          IF(KK.EQ.1.AND.IST.EQ.1) DENS(I,J)=0.
ISN 0175       10 CONTINUE
              C
              C   READ AND WRITE ATMOSPHERE DESCRIPTION CARDS
              C
ISN 0176          READ(5,100)(INDIC(K),K=1,5),(IDIST(K),K=1,5),NLAYER,NSOL,NMAX,
                 .NSCA,NALB,(IUNIT(K),K=1,5),(NTOT(K),K=1,5)
              C
              C   READ AMBIANT ATMOSPHERIC COMPONENTS
ISN 0177          READ(5,102)(INDICA(K),K=1,5)
ISN 0178          READ(5,102)(SCALE(K),K=1,5)
ISN 0179          NSP=0
              C
              C   SCAN TO FIND HOW MANY SPECIES ARE PRESENT
              C
ISN 0180          DO 17 K=1,5
ISN 0181          IF(INDIC(K).GE.5)GO TO 17
ISN 0183          NSP=NSP+1
ISN 0184          KMAX=K
ISN 0185       17 CONTINUE
ISN 0186          READ(5,96)AR,BR
ISN 0187          AR=AR*1.0E-25
ISN 0188       96 FORMAT(2F8.6)
ISN 0189          READ(5,97)ADEF,EXPFAC
ISN 0190       97 FORMAT(2F8.5)
ISN 0191          READ(5,190)INDOZ,INDOCZ
              C
              C
ISN 0192          IF(NALB.EQ.0)NALB=3
              C
              C   SET UP SUNS
              C
              C
              C
              C   STANDARD SUNS ARE ISKY = 0  USER SPECIFIED SUNS
              C                     ISKY = 1  STANDARD SUNS AT THETA=0,30,60,PHI=0
              C                     ISKY = 2  STANDARD SUNS AT THETA=0,30,60,PHI=PI/4
              C                     ISKY = 3  STANDARD SUNS AT THETA=0,30,60,PHI=PI/2
ISN 0194          SOLC=1.
ISN 0195          READ(5,95)SOLCON
ISN 0196          IF(SOLCON.NE.0.)SOLC=SOLCON
ISN 0198      300 CONTINUE
ISN 0199          IF(ISKY.EQ.0)GO TO 14
```



```
ISN 0201          NSOL=3
ISN 0202          PHI=FLOAT(ISKY-1)*PI/4.
ISN 0203          SP=SIN(PHI)
ISN 0204          CP=COS(PHI)
ISN 0205          DO 15 ISUN=1,NSOL
ISN 0206          CU=COS(SOLSTD(ISUN)*RADCON)
ISN 0207          SU=SIN(SOLSTD(ISUN)*RADCON)
ISN 0208          SOLDIR(ISUN,1)=SU*CP
ISN 0209          SOLDIR(ISUN,2)=SU*SP
ISN 0210          SOLDIR(ISUN,3)=CU
ISN 0211          US(ISUN)=SOLDIR(ISUN,1)
ISN 0212          VS(ISUN)=SOLDIR(ISUN,2)
ISN 0213          WS(ISUN)=SOLDIR(ISUN,3)
ISN 0214       15 CONTINUE
ISN 0215          GO TO 200
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0216         14 CONTINUE
ISN 0217            DO 151 ISUN=1,NSUN
ISN 0218            READ(5,107)SBET,SPHI
ISN 0219            SB=SIN(SBET*RADCON)
ISN 0220            CB=COS(SBET*RADCON)
ISN 0221            SP=SIN(SPHI*RADCON)
ISN 0222            CP=COS(SPHI*RADCON)
ISN 0223            SOLDIR(ISUN,1)=SB*CP
ISN 0224            SOLDIR(ISUN,2)=SB*SP
ISN 0225            SOLDIR(ISUN,3)=CB
ISN 0226            US(ISUN)=SOLDIR(ISUN,1)
ISN 0227            VS(ISUN)=SOLDIR(ISUN,2)
ISN 0228        151 WS(ISUN)=SOLDIR(ISUN,3)
ISN 0229        200 CONTINUE
ISN 0230            IF(IMP.GE.1.AND.IST.EQ.0)GO TO 1005
ISN 0232            DO 1 K=1,KMAX
ISN 0233            IF(INDIC(K).GE.5) GO TO 1
ISN 0235            IU=IUNIT(K)
ISN 0236            IF(IU.GT.5) REWIND IU
ISN 0238            IF(KK.EQ.2.OR.IST.EQ.0) GO TO 201
          C
          C         READ IN  COMPONENT SIZE DISTRIBUTION PARAMETERS
          C
ISN 0240            READ(5,101)NK(K),STEP(K),A1(K),B1(K),C1(K),ITAPE(K)
ISN 0241            NUMK(K)=(NK(K)-1)/2
ISN 0242        201 NUM=NUMK(K)
ISN 0243            N=NK(K)
ISN 0244            IF(K.GT.1.AND.INDIC(K).GE.5)GO TO 1111
ISN 0246            IF(INDIC(K).EQ.1.OR.INDIC(K).EQ.2)ST=STEP(K)*WAV/PI
ISN 0248            IF(IDIST(K).EQ.1)D1(K)=(B1(K)-1.)*A1(K)**(B1(K)-1.)
ISN 0250            IF(IDIST(K).EQ.3)D1(K)=A1(K)/SQRT(PI)
ISN 0252            IF(IDIST(K).EQ.4)D1(K)=(B1(K)-1.)/((B1(K)-1.)*(A1(K)-C1(K))+A1(K)
           *)
ISN 0254            IF(IDIST(K).NE.2)GO TO 2
ISN 0256            IT=1
ISN 0257            II=(A1(K)+1.)/C1(K)+0.5
ISN 0258            DO 3 I=3,II
ISN 0259          3 IT=IT*(I-1)
ISN 0260            C1(K)=C1(K)*B1(K)**II/FLOAT(IT)
ISN 0261            D1(K)=C1(K)*2.**(-A1(K)-1.)
ISN 0262            B1(K)=B1(K)*2.**(-C1(K))
ISN 0263          2 II=INDIC(K)+1
          C
          C         SET UP EXTINCTION CROSS SECTIONS (CSECT), ABSORPTION CROSS
          C         SECTIONS (ASECT), SCATTERING ANGLES (X), AND S11 FOR
          C         ALLOWED TYPES OF SCATTERERS
          C
ISN 0264            GO TO(4,5,6,7,8),II
          C
          C         RAYLEIGH
          C
ISN 0265          4 CONTINUE
ISN 0266            CSECT(K)=AR*WAV**(-BR)
ISN 0267            ASECT(K)=0.
ISN 0268            XA=RADCON*180./FLOAT(N-1)
ISN 0269            DO 18 I=1,N
ISN 0270            X(K,I)=XA*FLOAT(I-1)
ISN 0271            CA=COS(X(K,I))
ISN 0272         18 S11(I,K)=0.75*(1.+CA*CA)
ISN 0273            GO TO 20
ISN 0274       1111 DO 1112I=1,NLAYER
ISN 0275       1112 CDF(K,I)=CDF(K-1,I)
ISN 0276            GO TO 1
          C
          C         MONODISPERSE MIE
```



```
          C
ISN 0277          5 NI=INT(A1(K)/STEP(K)+0.5)
ISN 0278            DO 9 I=1,NI
ISN 0279            READ(IU        )REFACT,ALPHA,QSCA,QCSEAR,QEXT
ISN 0280            RN(K)=REFACT
ISN 0281            DO 9 J=1,N
ISN 0282            READ(IU        )XA,A1,A2,S33(J,K,I),S34(J,K,I),S11(J,K   ),S12(J,K,I)
ISN 0283            X(K,J)=XA*RADCON
ISN 0284            S34(J,K,I) = -S34(J,K,I)
ISN 0285          9 CONTINUE
ISN 0286            D=WAV*ALPHA/PI
```

```
ISN 0287          DMAX(K)=D
ISN 0288          F=PI*D*D*1.25E-08
ISN 0289          CSECT(K)=CEXT*F
ISN 0290          ASECT(K)=F*(CEXT-CSCA)
ISN 0291          GO TO 20
             C
             C    POLYDISPERSE MIE
             C
ISN 0292        6 NT=NTCT(K)
ISN 0293          IF(ITAPE(K).NE.0)READ(IU)NT,ST
ISN 0295          IF(ITAPE(K).NE.0)ST=ST**AV/PI
ISN 0297          NSTP(K)=NT
ISN 0298          CSECT(K)=0.
ISN 0299          ASECT(K)=0.
ISN 0300          DO 12 J=1,N
ISN 0301          S11(J,K)=0.
ISN 0302          S12(J,K,1)=0.
ISN 0303          S33(J,K,1)=0.
ISN 0304       12 S34(J,K,1)=0.
ISN 0305          DELD(K)=ST
ISN 0306          DO 11 I=1,NT
ISN 0307          READ(IU)REFACT,ALPHA,CSCA,COSBAR,CEXT
ISN 0308          RN(K)=REFACT
ISN 0309          D=WAV*ALPHA/PI
ISN 0310          DMAX(K)=D
ISN 0311          FF=FUNCT(A1(K),B1(K),C1(K),D1(K),IDIST(K),D)
ISN 0312          ASECT(K)=ASECT(K)+PI*D*D*FF*ST*(CEXT-CSCA)
ISN 0313          CSECT(K)=CSECT(K)+PI*D*D*CEXT*FF*ST
ISN 0314          DO 11 J=1,N
ISN 0315          READ(IU       )XA,AA,BB,XX3,XX4,YY,XX2
ISN 0316          X(K,J)=XA*RADCON
ISN 0317          S11(J,K)=S11(J,K)+FF*YY
ISN 0318          S12(J,K,1)=S12(J,K,1)+FF*XX2
ISN 0319          S33(J,K,1)=S33(J,K,1)+FF*XX3
ISN 0320       11 S34(J,K,1)=S34(J,K,1)-FF*XX4
ISN 0321          CSECT(K)=CSECT(K)*0.25E-08
ISN 0322          ASECT(K)=ASECT(K)*0.25E-08
ISN 0323          GO TO 20
             C
             C    SCATTERER DATA FROM EXPERIMENT ON CARDS
             C
ISN 0324        7 READ(5,104)CSECT(K),ASECT(K)
ISN 0325          DO 13 J=1,N
ISN 0326          READ(5,103)XA,S11(J,K   ),S12(J,K,1),S22(J,K,1),S33(J,K,1),
                 1S34(J,K,1),S44(J,K,1)
ISN 0327       13 X(K,J)=XA*RADCON
ISN 0328          GO TO 20
             C
             C    OZONE
             C
ISN 0329        8 CONTINUE
ISN 0330          CSECT(K)=ADEF
ISN 0331          CSECT(K)=CSECT(K)/2.6870E+19
ISN 0332          ASECT(K)=CSECT(K)
ISN 0333       41 CONTINUE
ISN 0334          GO TO 1
             C
             C    SET UP (NORMALIZED) SCATTERING MATRIX ELEMENTS FOR THIS
             C    SPECIES (K) AND EACH ANGLE
             C
ISN 0335       20 DO 21 I=1,N
             C          CALCULATE THBAR
ISN 0336          Y2(I)=S11(I,K)*SIN(X(K,I))
ISN 0337          THINT(I)=Y2(I)*X(K,I)
ISN 0338          THSINT(I)=Y2(I)*X(K,I)*X(K,I)
ISN 0339       21 CONTINUE
ISN 0340          THSBR=0.
ISN 0341          THBAR=0.
ISN 0342          SUM=0.
```



```
ISN 0343          DO 22 I=1,NUM
ISN 0344          K1=2*I
ISN 0345          X1(K,I)=X(K,K1+1)
ISN 0346          H=(X(K,K1+1)-X(K,K1-1))/6.
ISN 0347          CX21=X(K,K1)-X(K,K1-1)
ISN 0348          CX32=X(K,K1+1)-X(K,K1)
ISN 0349          CX31=36.*H*H
ISN 0350          W1=2.-CX32/CX21
```

```
ISN 0351           W2=CX31/CX32/CX21
ISN 0352           W3=2.-CX21/CX32
ISN 0353           SUM=SUM+H*(Y2(K1-1)*W1+Y2(K1)*W2+Y2(K1+1)*W3)
ISN 0354           THBAR=THBAR+H*(THINT(K1-1)*W1+THINT(K1)*W2+THINT(K1+1)*W3)
ISN 0355           THSQR=THSQR+H*(THSINT(K1-1)*W1+THSINT(K1)*W2+THSINT(K1+1)*W3)
ISN 0356        22 Y1(K,I)=SUM
ISN 0357           SUM=2./SUM
ISN 0358           THSQR=.5*SUM*THSQR
ISN 0359           THBAR=.5*SUM*THBAR
ISN 0360           SDTH=SQRT(THSQR-THBAR*THBAR)
ISN 0361           DO 23 I=1,N
ISN 0362           S11(I,K)= S11(I,K)*SUM
ISN 0363           IF(INDIC(K).EQ.0)GO TO 23
ISN 0365           S12(I,K,1)=S12(I,K,1)*SUM
ISN 0366           S33(I,K,1)=S33(I,K,1)*SUM
ISN 0367           S34(I,K,1)=S34(I,K,1)*SUM
ISN 0368           IF(.NOT.(IND.EQ.5.OR.IND.EQ.7))GO TO 30
ISN 0370           S12(I,K,1)=0.
ISN 0371           S33(I,K,1)=0.
ISN 0372           S34(I,K,1)=0.
ISN 0373           S22(I,K,1)=0.
ISN 0374           S44(I,K,1)=0.
ISN 0375        30 CONTINUE
ISN 0376           IF(INDIC(K).NE.3)GO TO 23
ISN 0378           S22(I,K,1)=S22(I,K,1)*SUM
ISN 0379           S44(I,K,1)=S44(I,K,1)*SUM
ISN 0380        23 CONTINUE
ISN 0381           SUM=0.5*SUM
ISN 0382           DO 24 I=1,NUM
ISN 0383        24 Y1(K,I)=Y1(K,I)*SUM
ISN 0384           IF(INDIC(K).EQ.0)GO TO 1
ISN 0386           DO 25 I=1,N
ISN 0387           AA=1./S11(I,K)
ISN 0388           S12(I,K,2)=S12(I,K,1)*AA
ISN 0389           S33(I,K,2)=S33(I,K,1)*AA
ISN 0390           S34(I,K,2)=S34(I,K,1)*AA
ISN 0391           IF(INDIC(K).NE.3)GO TO 25
ISN 0393           S44(I,K,2)=S44(I,K,1)*AA
ISN 0394           S22(I,K,2)=S22(I,K,1)*AA
ISN 0395        25 CONTINUE
ISN 0396         1 CONTINUE
              C
              C    IF WE ARE TREATING HIGHER WAVELENGTH OF A PAIR OR IF ATMOSPHERE
              C    CHARACTERISTICS HAVE ALREADY BEEN READ IN (IST=0)SKIP
              C
ISN 0397           IF(KK.EQ.2.OR.IST.EQ.0) GO TO 39
ISN 0399           DO 35 I=1,NLAYER
              C
              C    READ IN LAYER HEIGHT AND TEMPERATURE
              C
ISN 0400           READ(5,99)XH(I),TEMP(I)
ISN 0401        35 CONTINUE
ISN 0402           DO 38 I=1,NLAYER
ISN 0403           XLOW=0.
ISN 0404           IF(I.NE.1)XLOW=XH(I-1)
ISN 0406           DX(I)=XH(I)-XLOW
ISN 0407        38 CONTINUE
ISN 0408           TOTOZ=0.
ISN 0409           DO 36 K=1,KMAX
              C
              C    SKIP IF SPECIES NOT PRESENT
              C
ISN 0410           IF(INDICA(K).GE.5)GO TO 36
ISN 0412           DO 37 I=1,NLAYER
              C
              C    READ IN LAYER HEIGHT AND DENSITY OF K TH  SPECIES IN THAT LAYER
              C
ISN 0413           READ(5,98)XH(I),DENS(K,I)
              C
ISN 0414           IF(K.EQ.1.AND.INDOZ.NE.0)DENS(K,I)=DENS(K,I)*2.687E+10
ISN 0416           IF(K.EQ.1.AND.INDOZ.EQ.1)DENS(K,I)=DENS(K,I)*273./TEMP(I)
ISN 0418           IF(K.EQ.1.AND.I.NE.1)TOTOZ=TOTOZ+(XH(I)-XH(I-1))*DENS(1,I)
```



```
              C    CALCULATE TOTAL OZONE
              C
ISN 0420        37 CONTINUE
ISN 0421        36 CONTINUE
ISN 0422           TOTOZ=(TOTOZ+DENS(1,1)*XH(1))/2.687E+14
```

```
                C
                C         CHECK TOTAL VERTICAL OPTICAL THICKNESSES AND SCALE THEM
                C         TO THE VALUES SPECIFIED BY SCALE (IF SCALE .NE. 0.)
                C
ISN 0423              DO 60 K=1,KMAX
ISN 0424              IF(INDICA(K).GE.5)SCALE(K)=0.
ISN 0425              IF(INDICA(K).GE.5)GO TO 60
ISN 0428              S=0.
ISN 0429              DO 61 I=1,NLAYER
ISN 0430              IF(I.EQ.1)S=XH(I)*CSECT(K)*DENS(K,I)*1.E+05
ISN 0432              IF(I.NE.1)S=S+(XH(I)-XH(I-1))*CSECT(K)*DENS(K,I)*1.E+05
ISN 0434           61 CONTINUE
ISN 0435              IF(SCALE(K).GT.0.)CSECT(K)=CSECT(K)*SCALE(K)/S
ISN 0437              IF(SCALE(K).LT.0.)ASECT(K)=ASECT(K)*SCALE(K)/S
ISN 0439              IF(SCALE(K).LE.0.)SCALE(K)=S
ISN 0441           60 CONTINUE
ISN 0442           39 IF(EXPFAC.EQ.0..OR.KK.EQ.2)GO TO 55
ISN 0444              SCALHT=(XH(NLAYER)-XH(1))/ALOG(DENS(2,NLAYER)/DENS(2,1))
ISN 0445              FFF=1.+EXPFAC*SCALHT
ISN 0446              DO 54 I=1,NLAYER
ISN 0447           54 DENS(2,I)=DENS(2,1)*EXP(EXPFAC*(XH(I)-XH(1)))*FFF
ISN 0448           55 DO 26 I=1,NLAYER
ISN 0449              DO 29 K=1,KMAX
ISN 0450              IF(K.NE.1)CDF(K,I)=CDF(K-1,I)
ISN 0452              IF(INDICA(K).GE.5)GO TO 29
ISN 0454              IF(K.NE.1)GO TO 28
ISN 0456           33 CONTINUE
ISN 0457              ASECT(K)=CSECT(K)
ISN 0458              GO TO 27
                C
                C         CREATE CUMULATIVE DISTRIBUTION FUNCTION (CDF)
                C
ISN 0459        28    CDF(K,I)=CDF(K-1,I)+CSECT(K)*DENS(K,I)
ISN 0460        27    CDF(1,I)=CDF(1,I)+ASECT(K)*DENS(K,I)
ISN 0461        29    CONTINUE
                C
                C         SET UP OPTICAL THICKNESS PARAMETERS TCR,TORT,TOL
                C
ISN 0462              IF(I.EQ.1) TCR(I)=XH(I)*CDF(KMAX,I)*1.E+5
ISN 0464              IF(I.EQ.1) TORT(I)=TCR(I)
ISN 0466              IF(I.NE.1) TCR(I)=(XH(I)-XH(I-1))*CDF(KMAX,I)*1.E+5
ISN 0468              IF(I.NE.1) TORT(I)=TORT(I-1)+TCR(I)
ISN 0470              TOL(I)=CDF(KMAX,I)*1.E+5
ISN 0471              S=1./CDF(KMAX,I)
ISN 0472              DO 19 K=1,KMAX
ISN 0473              IF(INDICA(K).GE.5)GO TO 19
                C
                C         NORMALIZE CUMULATIVE DISTRIBUTION FUNCTION
                C
ISN 0475              CDF(K,I)=CDF(K,I)*S
ISN 0476           19 CONTINUE
ISN 0477        26    CONTINUE
                C
                C
                C         READ IN CLOUD PARAMETERS
ISN 0478         1022 CONTINUE
                C
ISN 0479              CALL CLINP
ISN 0480              NCLD1=NCLOUD+1
                C
                C         SET UP RECEIVER AND PHOTON INITIALIZATION PARAMETERS
ISN 0481         1021 CONTINUE
ISN 0482              READ(5,499)IRCLD,IREC,RECANG,HR,CZC,PPHI,RX,RY,SZCR,IAPATT,NTCCN
ISN 0483              IF((NTCCN.GT.0).AND.(NTCCN.LE.20))NCCN=NTCCN
ISN 0485              IF((IAPATT.GT.0).AND.(IAPATT.LE.NALE))IAPAT=IAPATT
ISN 0487              IF(SZCR.EQ.0.)SZC=SQRT(1.-CZC*CZC)
ISN 0489              IF(SZCR.NE.0.)SZC=SZCR
ISN 0491              IF(SZCR.NE.0.)CZC=SIGN((SQRT(1.-SZC*SZC)),CZC)
ISN 0493         1020 IF(IND.EQ.1.AND.KK.EQ.2)IREC=-IREC
                C              FOV IN MILLIRADIANS
ISN 0495              RECANG=RECANG*.5E-03
ISN 0496              CREC=COS(RECANG)
ISN 0497              IF(IRCLD.NE.0)GO TO 720
                C
                C         RECEIVER NOT ON A CLOUD
```

```
      UNR=-SIN(RADCON*RPHI)
      VNR=COS(RADCON*RPHI)
      WNR=0.
      CINR(1)=RX
      CINR(2)=RY
      CINR(3)=HR
      CINR(4)=SZC*VNR
      CINR(5)=SZC*(-UNR)
      CINR(6)=CZC
      CHT=0.
      GO TO 721
  720 IFACE=IABS(IREC)
      IFC1=(IFACE+1)/2
      IFC2=MOD(IFC1,3)+1
      IFC3=MOD(IFC1+1,3)+1
      IFACE=IFACE/2
      FACTR=+1.
      IF(IFC1.EQ.IFACE)FACTR=-1.
C
C     FACTR=-1. FOR RECEIVER ON (-) FACE
C
      FCINTR=+1.
      IF(IREC.GT.0)FCINTR=-1.
      CINR(IFC1+3)=FACTR*FCINTR
      CINR(IFC2+3)=0.
      CINR(IFC3+3)=0.
      CHT=0.
      IF(IREC.GT.0)CHT=CLOUD(INCLD,3)
      UNR=0.
      VNR=0.
      WNR=0.
      CNRE=ABS(CINR(6))
      IF(CNRE.NE.1.)GO TO 715
      VNR=+1.
      GO TO 716
  715 CONTINUE
      UNR=-CINR(5)
      VNR=CINR(4)
  716 CONTINUE
      IF(IREC.GT.0)GO TO 721
      INDC=+1
      CALL TRANS2(UNR,VNR,WNR,UNR,VNR,WNR,INCLD,INDC)
  721 CONTINUE
      DO 1001 ISUN=1,NSUL
      DO 1001 IJ=1,3
 1001 WSUN(NCLD1,ISUN,IJ)=SCLDIR(ISUN,IJ)
      IF(NCLOUD.EQ.0)GO TO 1002
      DO 1003 ICL=1,NCLOUD
      DO 1004 ISUN=1,NSUL
      INDC=-1
      CALL TRANS2(WSUN(ICL,ISUN,1),WSUN(ICL,ISUN,2),WSUN(ICL,ISUN,3),
     *WSUN(NCLD1,ISUN,1),WSUN(NCLD1,ISUN,2),WSUN(NCLD1,ISUN,3),ICL,INDC)
 1004 CONTINUE
 1003 CONTINUE
 1002 CONTINUE
      IF(IST.EQ.0)GO TO 1005
C
C     CLOUD PARAMETERS
      DO 752 INCLD=1,10
      ACLD(INCLD)=0.
  752 TOLCLD(INCLD)=0.
      IF(NCLOUD.EQ.0)GO TO 751
C
      DO 750 INCLD=1,NCLOUD
      K=INC(INCLD)
      TOLCLD(INCLD)=CSECT(K)*CLDEN(INCLD)*1.E+5
      ACLD(INCLD)=0.
      IF(CSECT(K).NE.0.)ACLD(INCLD)=ASECT(K)/CSECT(K)
  750 CONTINUE
  751 CONTINUE
      READ(5,140)IRPAT,IRBGC,XBND,TFN,TWSPD,TW0,TW1,TWSIG2
      WSPD=TWSPD
      WC0=.0015
      WC1=3.54E-03
      IF(TW0.NE.0.)WC0=TW0
      IF(TW1.NE.0.)WC1=TW1
      WSIG2=WC0+WC1*TWSPD
      IF(TWSIG2.NE.0.)WSIG2=TWSIG2
      WSIG=SQRT(WSIG2)
      FN=1.339
```

ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0584              IF(IFN.NE.0)FN=IFN
ISN 0586              IF(IRPAT.LT.2)GO TO 144
ISN 0588              READ(5,141)NSPOT
ISN 0589              DO 142 ISPCT=1,NSPOT
ISN 0590              READ(5,143)CNTRX(ISPCT),CNTRY(ISPCT),EDGEX(ISPCT),EDGEY(ISPCT)
ISN 0591          142 CONTINUE
ISN 0592          144 CONTINUE
ISN 0593              IRSPOT=IRBGD
ISN 0594              IF(IRPAT.NE.0)IRSPOT=MOD(IRECD+1,2)
ISN 0596         1005 CONTINUE
ISN 0597              TOT=0.
ISN 0598              DO 40 I=1,NLAYER
ISN 0599              DUM1(I)=TCRT(NLAYER)-TCRT(I)
ISN 0600              DUMMY(I)=1.-COF(1,1)
ISN 0601              DUM2(I)=TCR(I)*DUMMY(I)
ISN 0602           40 TOT=TOT+DUM2(I)
ISN 0603              IMPJ=INT(TCRT(NLAYER))
ISN 0604              IF(IMPJ.LT.1)IMPJ=1
                C
                C     MAIN TITLE
ISN 0606              WRITE(6,400)
                C
                C...  SIMULATION PARAMETERS
ISN 0607              WRITE(6,401)
ISN 0608              WRITE(6,411)AAV
ISN 0609              WRITE(6,412)NMAX,NSCA,NLAYER,IRAND
ISN 0610              WRITE(6,413)(INDIC(IPR),IPR=1,5),(ICIST(IPR),IPR=1,5),NLAYER,NSCL,
                     .NMAX,NSCA,NALB,(IUNIT(IPR),IPR=1,5),(NTOT(IPR),IPR=1,5)
ISN 0611              WRITE(6,471)
ISN 0612              IF(IMF.EQ.3)WRITE(6,753)IMPJ,SDTH
ISN 0614              IF(IND.EQ.5.OR.IND.EQ.7)WRITE(6,427)
ISN 0616              IF(IND.EQ.6.OR.IND.EQ.7)WRITE(6,428)
ISN 0618              IF(INDCZ.EQ.0)WRITE(6,415)
ISN 0620              IF(INDCZ.EQ.1)WRITE(6,416)
ISN 0622              IF(INDCZ.EQ.2)WRITE(6,417)
ISN 0624              WRITE(6,41)ADEF
ISN 0625              IF(EXPFAC.NE.0.)WRITE(6,641)EXPFAC
ISN 0627              WRITE(6,642)AR,BR
ISN 0628          642 FORMAT(1H0,44HRAYLEIGH CROSS SECTION IS PROPORTIONAL TO ,
                     .1H(,E14.7,14H)*(LAMBDA)**(-,F10.7,1H))
ISN 0629              THSQP=THSQR*(180./PI)**2
ISN 0630              THRMS=SQRT(THSQP)
ISN 0631              WRITE(6,550)THSQP,THRMS
                C
                C     RECEIVER TITLE
                C
ISN 0632              WRITE(6,402)
ISN 0633              IF(IRCLD.EQ.0.OR.NCLOUD.EQ.0)WRITE(6,420)FR,RX,RY
ISN 0635              IF(IRCLD.EQ.0.OR.NCLOUD.EQ.0)WRITE(6,421)CZC,SZC,RPHI
ISN 0637              RZA=ARCOS(ABS(CZC))/RADCON
ISN 0638              IF((CZC.GT.0.).AND.(IRCLD.EQ.0.OR.NCLOUD.EQ.0))WRITE(6,4210)RZA
ISN 0640              IF((CZC.LE.0.).AND.(IRCLD.EQ.0.OR.NCLOUD.EQ.0))WRITE(6,4211)RZA
ISN 0642              IF(NCLOUD.EQ.0)GO TO 199
ISN 0644              IF(IRCLD.EQ.0)GO TO 199
ISN 0646              XFACE=FACTR*CLOUD(IRCLD,IFC1+3)
ISN 0647              WRITE(6,424)XCAP(IFC1),XFACE,IRCLD
ISN 0648              IF(IRCLD.NE.0.AND.IREC.LT.0)WRITE(6,426)
ISN 0650              IF(IRCLD.NE.0.AND.IREC.GT.0)WRITE(6,425)
ISN 0652          199 CONTINUE
ISN 0653              CONANG=2.*RECANG
ISN 0654              WRITE(6,422)CONANG
                C
                C     SOLAR ARRAY TITLE
                C
ISN 0655              WRITE(6,403)
ISN 0656              WRITE(6,436)SOLC
ISN 0657              WRITE(6,430)
ISN 0658              DO 500 ISCL=1,NSOL
ISN 0659              WRITE(6,431)ISOL,US(ISCL),VS(ISCL),WS(ISCL)
ISN 0660              IF(ISKY.EQ.0)WRITE(6,433)
ISN 0662              IF(ISKY.NE.0)WRITE(6,434)
ISN 0664          500 CONTINUE
                C
                C     GROUND TITLE
                C
ISN 0665              WRITE(6,404)
                C           REFLECTANCE MAP
ISN 0666              WRITE(6,360)
```

```
ISN 0667               WRITE(6,561)
ISN 0668               IF(IRPAT.NE.0)GO TO 130
```



```
ISN 0670               WRITE(6,562)
ISN 0671               IF(IRBGD.EQ.0)WRITE(6,563)
ISN 0673               IF(IRBGD.EQ.1)WRITE(6,564)
ISN 0675           130 IF(IABS(IRPAT).NE.1)GO TO 131
ISN 0677               WRITE(6,565)XBND
ISN 0678               ILOC=IRBGD+1+(IRPAT+1)/2+1
ISN 0679               ILOCT=(ILOC/2)*2
ISN 0680               IF(ILOCT.EQ.ILOC)WRITE(6,566)
ISN 0682               IF(ILOCT.NE.ILOC)WRITE(6,567)
ISN 0684               WRITE(6,568)XBND
ISN 0685           131 IF(IRPAT.NE.2)GO TO 132
ISN 0687               WRITE(6,568)
ISN 0688               IF(IRBGD.EQ.0)WRITE(6,563)
ISN 0690               IF(IRBGD.EQ.1)WRITE(6,564)
ISN 0692               WRITE(6,569)
ISN 0693               IF(IRBGD.EQ.0)WRITE(6,571)
ISN 0695               IF(IRBGD.EQ.1)WRITE(6,570)
ISN 0697               WRITE(6,572)
ISN 0698               DO 133 IPR=1,NSPOT
ISN 0699           133 WRITE(6,573)CNTRX(IPR),CNTRY(IPR),EDGEX(IPR),EDGEY(IPR)
ISN 0700           132 IF(IRBGD.EQ.0.AND.IRSPOT.EQ.0)GO TO 134
ISN 0702               WRITE(6,574)FN,WSIG2
ISN 0703               IF(WSIG2.NE.0.)GO TO 134
ISN 0705               WRITE(6,578)WC0,WC1,WSPD
ISN 0706           134 CONTINUE
ISN 0707               WRITE(6,443)NALB
ISN 0708               DO 442 IALB=1,NALB
ISN 0709               NALB=-IALB
ISN 0710           442 CALL ALBEDO(NALB,ALBPT)
                 C
                 C     ATMOSPHERIC TITLE
                 C
ISN 0711               WRITE(6,408)
ISN 0712               WRITE(6,450)TCTOZ,NLAYER
ISN 0713               WRITE(6,451)NSP
ISN 0714               NN=0
ISN 0715               DO 501 K=1,KMAX
ISN 0716               IF(INDIC(K).GE.5)GO TO 501
ISN 0718               NN=NN+1
ISN 0719               IF(INDIC(K).EQ.0)WRITE(6,454)NN
ISN 0721               IF(INDIC(K).EQ.4)WRITE(6,453)NN
ISN 0723               IF(INDIC(K).GE.1.AND.INDIC(K).LE.3)WRITE(6,455)NN
ISN 0725               WRITE(6,452)CSECT(K),ASECT(K)
ISN 0726               IF(INDIC(K).EQ.1)WRITE(6,456)A1(K)
ISN 0728               IF(INDIC(K).NE.2)GO TO 502
ISN 0730               WRITE(6,457)
ISN 0731               IF(IDIST(K).EQ.1)WRITE(6,458)A1(K),E1(K)
ISN 0733               IF(IDIST(K).EQ.2)WRITE(6,460)A1(K),E1(K),C1(K)
ISN 0735               IF(IDIST(K).EQ.3)WRITE(6,459)A1(K),E1(K),C1(K)
ISN 0737           502 CONTINUE
ISN 0738               IF(IDIST(K).EQ.4)WRITE(6,434)C1(K),A1(K),E1(K)
ISN 0740               IF(INDIC(K).EQ.1)WRITE(6,467)CMAX(K)
ISN 0742               IF(INDIC(K).EQ.2)WRITE(6,468)DELD(K),CMAX(K),NSTP(K)
ISN 0744               WRITE(6,466)SCALE(K)
ISN 0745               IF(INDIC(K).GE.1.AND.INDIC(K).LE.3)WRITE(6,465)RN(K)
ISN 0747               IF(INDIC(K).EQ.3)WRITE(6,462)
ISN 0749               IF(INDIC(K).NE.4)WRITE(6,461)NK(K)
ISN 0751           501 CONTINUE
ISN 0752               NN=0
ISN 0753               WRITE(6,510)
ISN 0754               DO 509 K=1,KMAX
ISN 0755               IF(INDIC(K).GE.5)GO TO 509
ISN 0757               NN=NN+1
ISN 0758               WRITE(6,511)NN
ISN 0759               NNK=NUMK(K)
ISN 0760               DO 508 IK=1,NNK
ISN 0761               XANG=X1(K,IK)/RADCON
ISN 0762               WRITE(6,512)XANG,Y1(K,IK)
ISN 0763           508 CONTINUE
ISN 0764           509 CONTINUE
ISN 0765               NN=0
ISN 0766               DO 520 K=1,KMAX
ISN 0767               IF(INDIC(K).GE.5)GO TO 520
ISN 0769               NN=NN+1
ISN 0770               NNK=NK(K)
```

```
      ISN 0773            WRITE(6,521)NN
      ISN 0774            WRITE(6,523)
      ISN 0775            WRITE(6,522)
      ISN 0776            DO 524 IK=1,NNK
```



```
      ISN 0777            XANG=X(K,IK)/RADCON
      ISN 0778      524   WRITE(6,525)XANG,S11(IK,K),S12(IK,K,1),S33(IK,K,1),S34(IK,K,1)
      ISN 0779            WRITE(6,528)
      ISN 0780            WRITE(6,522)
      ISN 0781            DO 527 IK=1,NNK
      ISN 0782            XANG=X(K,IK)/RADCON
      ISN 0783            SX11=1.
      ISN 0784      527   WRITE(6,525)XANG,SX11,S12(IK,K,2),S33(IK,K,2),S34(IK,K,2)
      ISN 0785            WRITE(6,528)
      ISN 0786            WRITE(6,522)
      ISN 0787            DO 529 IK=1,NNK
      ISN 0788            SX11=S11(IK,K)/4./PI
      ISN 0789            SX12=S12(IK,K,1)/4./PI
      ISN 0790            SX33=S33(IK,K,1)/4./PI
      ISN 0791            SX34=S34(IK,K,1)/4./PI
      ISN 0792            XANG=X(K,IK)/RADCON
      ISN 0793      529   WRITE(6,525)XANG,SX11,SX12,SX33,SX34
      ISN 0794      520   CONTINUE
      ISN 0795      521   FORMAT(1H0,18X,'SCATTERING PHASE MATRIX ELEMENTS OF SPECIES ',I2)
      ISN 0796      523   FORMAT(1H0,28X,'NORMALIZED --- INTEGRAL OVER ALL SOLID ANGLES =4.*P
                         *I')
      ISN 0797      522   FORMAT(1H0,'THETA',10X,'S11',14X,'S12',14X,'S33',14X,'S34')
      ISN 0798      525   FORMAT(1H ,F8.3,4(2X,E14.7))
      ISN 0799      526   FORMAT(1H0,28X,'NORMALIZED BY S11')
      ISN 0800      528   FORMAT(1H0,28X,'NORMALIZED SO THAT INTEGRAL IS 1.')
      ISN 0801            IF(IMP.EQ.1)WRITE(6,651)THSEP
      ISN 0803            IF(IMP.EQ.2)WRITE(6,653)
      ISN 0805            IF(IMP.GE.1.AND.NSOL.GT.1)WRITE(6,652)NSOL
      ISN 0807            IF(IMP.GE.1.AND.NSOL.GT.1)NSOL=1
      ISN 0809            WRITE(6,463)
      ISN 0810            WRITE(6,105)(XH(I),DENS(1,I),DENS(2,I),DENS(3,I),DENS(4,I),DENS(5,
                         * I), TOR(I),TORT(I),TEMP(I),CDF(1,I),I=1,NLAYER)
      ISN 0811            WRITE(6,116)(XH(I),DUMI(I),DUMMY(I),DUM2(I),I=1,NLAYER)
      ISN 0812            WRITE(6,472)TOT
      ISN 0813            THOARD=THEAR*180./PI
      ISN 0814            WRITE(6,850)THOARD
                    C
                    C     CLOUD TITLE
      ISN 0815            WRITE(6,408)
      ISN 0816            IF(NCLCUD.EQ.0)WRITE(6,482)
      ISN 0818            IF(NCLCUD.NE.0)WRITE(6,481)NCLCUD
      ISN 0820            IF(NCLCUD.EQ.0)GO TO 489
      ISN 0822            WRITE(6,483)
      ISN 0823            DO 488 ICLD=1,NCLOUD
      ISN 0824      488   WRITE(6,484)ICLD,HCL(ICLD),ACL(ICLD),ECL(ICLD),CCL(ICLD),
                         *XCL(ICLD),YCL(ICLD),THDEG(ICLD),INC(ICLD),CLDEN(ICLD),TOLCLD(ICLD)
      ISN 0825      489   CONTINUE
      ISN 0826      198   CONTINUE
                    C
                    C**** TEST PRINT SECTION
                    C
      ISN 0827            DO 2001 ICL=1,NCLOI
      ISN 0828            DO 2001 ISUN=1,NSOL
      ISN 0829            DO 2001 IJP=1,3
      ISN 0830            WRITE(6,2002)ICL,ISUN,IJP,WSUN(ICL,ISUN,IJP)
      ISN 0831     2002   FORMAT(1H0,'ICL=',I2,2X,'ISUN=',I2,2X,'I=',I2,4X,'WSUN=',F10.6)
      ISN 0832     2001   CONTINUE
      ISN 0833            WRITE(6,2003)IFC1,IFC2,IFC3,FACTR,(CINR(IJP),IJP=1,6)
      ISN 0834     2003   FORMAT(1H0,'IFC1=',I2,2X,'IFC2=',I2,2X,'IFC3=',I2,4X,'FACTR=',F4.1
                         */1H ,'CINR=',6(E14.7,2X))
                    C****
                    C****
      ISN 0835            RETURN
      ISN 0836            END
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****


```
SYMBOL   INTERNAL STATEMENT NUMBERS
D          0286  0287  0288  0288  0309  0310  0311  0312  0312  0313  0313
F          0288  0289  0290
```

```
H      0346 0349 0349 0353 0354 0355
I      0170 0172 0173 0258 0259 0269 0270 0270 0271 0272 0274 0275 0275 0278 0284 0284 0306 0335 0336
       0336 0336 0337 0337 0337 0338 0338 0338 0338 0343 0344 0345 0355 0361 0362 0362 0365 0365 0366
       0366 0367 0367 0370 0371 0372 0373 0374 0378 0378 0379 0379 0382 0383 0383 0386 0387 0388 0388
       0389 0389 0390 0390 0393 0393 0394 0394 0399 0400 0400 0402 0404 0404 0406 0406 0412 0413 0413
       0414 0414 0416 0416 0416 0418 0418 0418 0418 0429 0430 0430 0432 0432 0432 0432 0446 0447 0447
       0447 0448 0450 0450 0459 0459 0459 0460 0460 0460 0462 0462 0462 0464 0464 0464 0466 0466 0466
       0466 0466 0466 0468 0468 0468 0470 0470 0471 0475 0475 0598 0599 0599 0600 0600 0601 0601 0601
       0612 0810 0810 0810 0810 0810 0810 0810 0810 0810 0810 0810 0810 0811 0811 0811 0811 0811 0811
J      0171 0172 0173 0281 0282 0282 0282 0282 0282 0282 0284 0284 0300 0301 0302 0303 0304 0314 0316 0317
       0317 0318 0318 0319 0319 0320 0320 0325 0326 0326 0326 0326 0326 0326 0326 0327
K      0176 0176 0176 0175 0176 0176 0176 0176 0176 0176 0176 0175 0176 0176 0177 0177 0177 0178 0178 0178 0180
       0181 0184 0232 0233 0235 0240 0240 0240 0240 0240 0240 0240 0240 0241 0241 0242 0243 0244 0244 0245 0246
       0246 0248 0248 0248 0248 0248 0250 0250 0250 0250 0252 0252 0252 0252 0252 0252 0252 0254 0257 0257
       0260 0260 0260 0261 0261 0261 0262 0262 0262 0262 0263 0266 0267 0270 0271 0272 0275 0275 0277 0277
       0282 0282 0282 0282 0282 0283 0284 0284 0287 0287 0289 0290 0292 0293 0295 0297 0298 0299 0301 0302
       0312 0314 0305 0308 0310 0311 0311 0311 0311 0311 0311 0312 0312 0313 0313 0316 0317 0317 0318 0318
       0319 0319 0320 0320 0321 0321 0322 0322 0324 0324 0324 0326 0325 0326 0326 0326 0326 0327 0330 0331
       0331 0332 0332 0336 0336 0337 0335 0339 0345 0345 0345 0346 0346 0347 0347 0348 0348 0356 0362 0362
       0363 0365 0365 0366 0366 0367 0367 0370 0371 0371 0372 0373 0374 0376 0378 0378 0379 0379 0383 0383
       0384 0387 0388 0388 0389 0389 0390 0390 0391 0391 0393 0393 0394 0394 0409 0410 0413 0414 0414 0414
       0416 0416 0416 0418 0423 0424 0424 0426 0430 0430 0430 0432 0432 0435 0435 0435 0435 0437 0437 0437
       0437 0439 0439 0449 0450 0450 0450 0452 0454 0454 0457 0457 0459 0459 0459 0459 0460 0460 0472 0473
       0475 0475 0564 0565 0567 0567 0567 0715 0716 0716 0719 0721 0723 0723 0725 0725 0726 0726 0728 0731
       0731 0731 0733 0733 0733 0733 0735 0735 0735 0735 0735 0738 0738 0738 0738 0740 0740 0742 0742 0742
       0742 0744 0745 0745 0745 0747 0749 0749 0754 0754 0755 0759 0761 0762 0766 0767 0770 0771 0771 0777
       0776 0778 0778 0778 0762 0764 0784 0784 0768 0768 0789 0790 0791 0792
N      0029 0243 0268 0269 0281 0309 0314 0325 0335 0335 0361 0386
S      0426 0430 0432 0432 0435 0437 0439 0471 0475
X      0018 0021 0270 0271 0263 0316 0327 0336 0337 0337 0338 0338 0345 0346 0346 0347 0347 0348 0348 0777
       0782 0792
AA     0315 0387 0388 0389 0390 0393 0394
AR     0165 0167 0167 0266 0627
A1     0008 0240 0248 0250 0252 0252 0257 0261 0277 0282 0311 0726 0731 0733 0735 0738
A2     0262
BB     0215
BR     0166 0266 0627
B1     0008 0240 0243 0248 0252 0252 0260 0262 0262 0311 0731 0733 0735 0738
CA     0271 0272 0272
CB     0210 0210 0220 0225
CG     0031
CP     0204 0208 0222 0223
C1     0006 0240 0252 0257 0260 0262 0311 0733 0735 0738
DX     0028 0466
D1     0008 0248 0250 0252 0260 0261 0261 0311
FA     0150
FF     0311 0312 0313 0317 0318 0319 0320
FN     0023 0583 0584 0702
HR     0035 0462 0504 0633
I1     0257 0258 0260 0263 0264
IJ     0545 0546 0546
IK     0700 0701 0762 0776 0777 0778 0778 0778 0778 0781 0762 0784 0784 0784 0787 0788 0789 0790 0791
       0792
IT     0258 0259 0259 0260
IU     0235 0236 0236 0279 0282 0293 0307 0315
JJ     0027
JK     0029
KK     0032 0165 0173 0238 0357 0442 0403
K1     0314 0345 0346 0346 0347 0347 0348 0348 0353 0353 0353 0354 0354 0354 0355 0355 0355
NK     0030 0240 0241 0243 0749 0770
NM     0030
NN     0714 0718 0718 0719 0721 0723 0752 0757 0757 0758 0765 0769 0769 0773
NT     0292 0293 0297 0306
N1     0277 0278
PI     0036 0159 0165 0202 0246 0250 0286 0288 0295 0309 0312 0313 0629 0788 0789 0790 0791 0813
RN     0014 0280 0306 0745
RX     0462 0502 0633
RY     0462 0503 0633
SB     0207 0208 0209 0219 0223 0224
SP     0203 0220 0221 0224
ST     0236 0293 0295 0295 0305 0312 0313
UN     0027
US     0026 0211 0226 0659
VN     0027
VS     0026 0212 0227 0659
WN     0027
```

ORIGINAL PAGE IS
OF POOR QUALITY

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

```
SYMBOL  INTERNAL STATEMENT NUMBERS
WS      0026 0213 0229 0659
W1      0350 0353 0354 0356
W2      0351 0353 0354 0355
W3      0352 0353 0354 0355
XA      0258 0270 0282 0283 0315 0316 0320 0327
XH      0008 0023 0400 0404 0406 0413 0418 0418 0422 0430 0432 0432 0444 0444 0447 0447 0462 0466 0466
        0810 0811
X1      0008 0021 0345 0761
YY      0315 0317
Y1      0008 0021 0356 0363 0363 0702
Y2      0008 0336 0337 0339 0353 0353 0353
ZX      0023
ZY      0023
ABS     0830 0837
ACL     0034 0824
ALU     0031
BCL     0034 0824
CCL     0034 0824
CDF     0008 0021 0172 0275 0275 0450 0450 0459 0459 0460 0460 0462 0466 0470 0471 0475 0475 0603 0810
CHT     0035 0518 0524 0526
CIN     0027
COS     0204 0205 0220 0222 0271 0496 0500
CZO     0035 0482 0487 0487 0491 0491 0507 0635 0637 0638 0640
EXP     0447
FFF     0445 0447
HCL     0034 0824
ICL     0549 0552 0552 0552 0552 0627 0830 0830
IJP     0629 0630 0630 0633 0633 0633
IMP     0024 0141 0230 0612 0801 0803 0805 0807
INC     0033 0554 0824
IND     0030 0163 0165 0368 0368 0493 0614 0614 0616 0616
INT     0277 0503
IPR     0016 0017 0610 0610 0610 0610 0610 0610 0610 0610 0610 0610 0698 0699 0699 0699 0699
IST     0030 0161 0167 0173 0230 0238 0397 0556
MOD     0512 0513 0594
NNK     0735 0760 0770 0776 0781 0787
NSP     0179 0183 0183 0712
NUM     0242 0343 0380
PHI     0272 0273 0274
RZA     0637 0638 0640
SIN     0213 0217 0219 0221 0336 0499
SUM     0342 0353 0353 0356 0357 0357 0358 0359 0362 0365 0366 0367 0378 0379 0381 0381 0383
S20     0035 0487 0489 0491 0491 0505 0506 0635
S11     0008 0021 0272 0282 0301 0317 0317 0326 0336 0362 0362 0387 0773 0788
S12     0008 0021 0282 0302 0318 0318 0320 0365 0365 0370 0388 0388 0778 0784 0789
S22     0008 0021 0326 0373 0378 0378 0394 0394
S33     0008 0021 0282 0303 0315 0319 0326 0356 0366 0371 0389 0389 0778 0784 0790
S34     0008 0021 0282 0284 0284 0304 0320 0320 0326 0367 0367 0372 0390 0390 0778 0784 0791
S44     0008 0021 0326 0374 0379 0379 0393 0393
TFN     0371 0584 0584
TOL     0028 0470
TOR     0028 0462 0464 0466 0468 0601 0810
TOT     0597 0602 0602 0812
TPI     0036
TWO     0571 0575 0575
TW1     0571 0577 0577
UNR     0035 0499 0506 0527 0536 0542 0542
VNR     0035 0500 0505 0528 0533 0537 0542 0542
WAV     0030 0160 0246 0266 0266 0295 0309 0608
WC0     0573 0575 0579 0705
WC1     0574 0577 0579 0705
WNG     0023
WNR     0035 0501 0529 0542 0542
XCL     0034 0824
XX2     0315 0318
XX3     0315 0319
XX4     0315 0320
YCL     0034 0824
ACLD    0033 0559 0566 0567
ADEF    0185 0330 0624
ALOG    0444
CINR    0035 0502 0503 0504 0505 0506 0507 0521 0522 0523 0530 0536 0537 0833
CNRG    0030 0331
CREC    0035 0496
CX21    0347 0350 0351 0352
CX31    0349 0351
CX32    0348 0350 0351 0352
```

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

SYMBOL   INTERNAL STATEMENT NUMBERS
DELD     0017  0315  0742
DENS     0008  0173  0413  0414  0414  0416  0416  0418  0422  0430  0432  0444  0444  0447  0447  0459  0460  0810  0810
         0810  0810  0810
DMAX     0017  0287  0310  0740  0742
DUM1     0012  0599  0811
DUM2     0013  0611  0602  0611
IABS     0010  0675
IALB     0708  0709
ICLD     0023  0824  0824  0824  0824  0824  0824  0824  0824  0824  0824  0824
IFC1     0035  0511  0512  0513  0516  0521  0646  0647  0833
IFC2     0035  0512  0522  0833
IFC3     0035  0513  0523  0833
IGND     0029
ILOC     0078  0679  0680  0682
IMPJ     0024  0603  0604  0604  0612
IMPX     0034
INDC     0041  0542  0551  0552
IREC     0035  0492  0493  0493  0510  0519  0525  0535  0648  0650
ISKY     0002  0199  0202  0660  0662
ISCL     0036  0659  0659  0659  0659
ISUN     0205  0206  0207  0208  0209  0210  0211  0211  0212  0212  0213  0213  0217  0223  0224  0225  0226  0226  0227
         0227  0228  0228  0544  0546  0546  0550  0552  0552  0552  0552  0552  0552  0828  0830  0830
KMAX     0030  0184  0232  0409  0423  0449  0462  0466  0470  0471  0472  0715  0754  0766
MALB     0709  0710
NALB     0031  0176  0192  0192  0485  0610  0707  0708
NCON     0039  0483
NMAX     0030  0176  0609  0610
NSCA     0030  0175  0609  0610
NSCL     0036  0176  0201  0205  0217  0544  0550  0610  0658  0805  0805  0807  0807  0828
NSTP     0017  0257  0742
NTOT     0010  0176  0292  0610
NUMK     0030  0241  0242  0769
QEXT     0279  0289  0290  0307  0312  0313
QSCA     0279  0290  0307  0312
RPHI     0482  0499  0500  0635
SBET     0215  0219  0220
SOTH     0024  0360  0612
SIGN     0491
SOLC     0038  0194  0196  0656
SOUT     0027
SPHI     0218  0221  0222
SORT     0250  0360  0487  0491  0582  0630
STEP     0008  0240  0246  0277
SX11     0783  0784  0788  0793
SX12     0789  0793
SX33     0790  0793
SX34     0791  0793
SZOR     0482  0487  0489  0485  0491
TEMP     0011  0400  0416  0810
TURT     0011  0028  0464  0468  0468  0599  0599  0603  0810
WSIG     0023  0582
WSPD     0072  0705
WSUN     0026  0546  0552  0552  0552  0552  0552  0552  0830
XANG     0761  0762  0777  0778  0782  0784  0792  0793
XGND     0022  0571  0677  0684
XCAP     0003  0049  0647
XLCW     0403  0404  0406
ALBPT    0710
ALPHA    0279  0286  0307  0309
ARCOS    0637
ASECT    0009  0267  0290  0299  0312  0312  0322  0322  0324  0332  0437  0437  0457  0460  0567  0725
CLDEN    0034  0365  0824
CLINP    0479
CLOUD    0032  0525  0646
CNTRX    0022  0593  0699
CNTRY    0022  0590  0699
CSECT    0009  0266  0289  0298  0313  0313  0321  0321  0324  0330  0331  0331  0332  0430  0432  0435  0435  0457  0459
         0565  0567  0567  0725
DUMMY    0012  0600  0601  0811
EDGEX    0032  0590  0699
EDGEY    0022  0590  0699
FACTR    0035  0515  0516  0521  0646  0833
FLOAT    0262  0260  0268  0270
FUNCT    0311
IAPAT    0039  0485
IDIST    0008  0176  0248  0250  0252  0254  0311  0610  0731  0733  0735  0738
```


ORIGINAL PAGE IS
OF POOR QUALITY

```
IFACE    0510  0511  0514  0514  0516
```



```
                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

 SYMBOL   INTERNAL STATEMENT NUMBERS
 ILOCT    0375  0687  0682
 INCLD    0327  0558  0559  0560  0563  0564  0565  0565  0566  0567
 INDIC    0325  0175  0181  0233  0244  0246  0246  0263  0363  0376  0384  0391  0610  0716  0719  0721  0723  0723  0726
          0728  0742  0742  0745  0745  0747  0749  0755  0767  0771  0771
 INDOZ    0191  0414  0416  0618  0620  0622
 INPUT    0012
 IRAND    0137  0659
 IRBGD    0022  0571  0553  0554  0671  0673  0678  0688  0690  0693  0695  0700
 IRCLD    0035  0482  0497  0525  0542  0633  0635  0638  0640  0644  0646  0647  0648  0650
 IRPAT    0022  0571  0586  0594  0668  0675  0676  0685
 ISPOT    0585  0590  0590  0590  0590
 ITAPE    0016  0240  0293  0295
 IUNIT    0015  0176  0235  0610
 NCLD1    0032  0481  0546  0552  0552  0552  0627
 NSPOT    0588  0589  0698
 NICON    0482  0483  0483  0483
 SCALE    0305  0178  0424  0435  0435  0437  0437  0439  0439  0744
 SIGMA    0008
 SCL4U    0016
 THBAR    0025  0159  0341  0354  0354  0359  0359  0360  0360  0813
 THDEG    0034  0224
 THINT    0007  0337  0354  0354  0354
 THRMS    0830  0831
 THSEP    0829  0630  0631  0801
 THSDR    0024  0340  0355  0355  0358  0358  0360  0629
 TOTUZ    0408  0419  0418  0422  0422  0712
 TWSPD    0571  0572  0579
 WAVEL    0008
 WSIG2    0023  0579  0580  0582  0702
 XFACL    0646  0647
 ALBEDO   0710
 CONANG   0653  0654
 COSBAR   0275  0307
 EXPFAC   0129  0442  0445  0447  0625  0625
 FACTOR   0030
 IAPATT   0462  0465  0465  0465
 INDCOZ   0191
 INDICA   0036  0177  0410  0424  0426  0452  0473
 INFLUX   0035
 INSPOT   0022  0593  0594  0700
 NCLOUD   0032  0480  0547  0549  0561  0563  0633  0635  0639  0640  0642  0816  0818  0818  0820  0823
 NLAYER   0026  0176  0274  0399  0402  0412  0429  0444  0444  0446  0448  0598  0599  0603  0609  0610  0712  0810  0811
 PCINTR   0029  0518  0519  0521
 RADCON   0109  0206  0207  0219  0220  0221  0222  0268  0283  0316  0327  0499  0500  0637  0761  0777  0782  0792
 RECANG   0035  0482  0495  0495  0496  0653
 REFACT   0020  0279  0230  0307  0308
 SCALHT   0444  0445
 SOLCON   0195  0196  0196
 SOLDIR   0014  0208  0209  0210  0211  0212  0213  0223  0224  0225  0226  0227  0228  0546
 SOLPHI   0016
 SOLSTO   0015  0041  0206  0207
 TAWSUN   0024
 THEARO   0613  0814
 THSINT   0019  0338  0355  0355  0355
 TOLCLD   0033  0560  0565  0824
 TRANS2   0542  0552
 TWSIG2   0571  0580  0580  0703
```



```
                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

 LABEL   DEFINED   REFERENCES
   1     0356      0232  0233  0276  0334  0384
   2     0203      0254
   3     0259      0258
   4     0265      0264
   5     0277      0264
   6     0252      0264
   7     0324      0264
   8     0329      0264
   9     0288      0278  0281
  10     0175      0170  0171
  11     0320      0306  0314
```


ORIGINAL PAGE IS
OF POOR QUALITY

13	0327	0325		
14	0216	0199		
15	0214	0205		
17	0185	0180	0181	
18	0272	0269		
19	0476	0472	0473	
20	0335	0273	0291	0323 0328
21	0339	0335		
22	0356	0343		
23	0360	0361	0363	0376
24	0383	0382		
25	0395	0386	0391	
26	0477	0449		
27	0460	0458		
28	0459	0454		
29	0461	0449	0452	
30	0375	0368		
33	0456			
35	0401	0399		
36	0421	0409	0410	
37	0420	0412		
38	0407	0402		
39	0442	0397		
40	0602	0598		
41	0333			
54	0447	0446		
55	0448	0442		
60	0441	0423	0426	
61	0434	0429		
95	0042	0195		
96	0188	0186		
97	0190	0189		
98	0043	0413		
99	0044	0400		
100	0045	0176	0177	0191
101	0046	0240		
102	0047	0178		
103	0048	0326		
104	0049	0324		
105	0050			
107	0051	0218		
109	0052	0810		
112	0053			
113	0054			
114	0055			
115	0056			
116	0057	0811		
117	0058			
118	0059			
119	0060			
120	0061			
121	0062			
123	0063			
130	0675	0658		
131	0685	0675		
132	0700	0685		
133	0695	0698		
134	0706	0700	0703	
140	0064	0571		
141	0065	0588		
142	0591	0589		
143	0166	0590		
144	0592	0586		
151	0223	0217		
198	0626			
199	0652	0642	0644	
200	0229	0215		

*****F O R T R A N C R O S S R E F E R E N C E L I S T I N G*****

LABEL	DEFINED	REFERENCES
201	0242	0236
300	0198	0161
400	0067	0606
401	0068	0607
402	0069	0632
403	0070	0655

404	0071	0665		
405	0072	0711		
406	0126	0615		
410	0093	0603		
411	0094			
412	0095	0609		
413	0096	0610		
414	0097			
415	0098	0618		
416	0099	0620		
417	0100	0622		
418	0101			
419	0102	0624		
420	0073	0633		
421	0074	0635		
422	0077	0654		
423	0078			
424	0079	0647		
425	0080	0650		
426	0081	0648		
427	0082	0614		
428	0083	0616		
430	0090	0657		
431	0084	0659		
432	0085			
433	0086	0630		
434	0087	0662		
435	0088			
436	0089	0656		
441	0091			
442	0710	0703		
443	0092	0707		
450	0103	0712		
451	0104	0713		
452	0109	0725		
453	0106	0721		
454	0107	0719		
455	0108	0723		
456	0110	0726		
457	0111	0730		
458	0112	0731		
459	0113	0735		
460	0114	0733		
461	0105	0749		
462	0115	0747		
463	0116	0839		
464	0117	0738		
465	0118	0745		
466	0119	0744		
467	0120	0740		
468	0121	0742		
470	0122			
471	0123	0611		
472	0124	0812		
473	0125			
481	0127	0813		
482	0128	0816		
483	0129	0822		
484	0130	0824		
488	0824	0823		
489	0825	0825		
499	0131	0482		
500	0664	0653		
501	0751	0715	0716	
502	0737	0728		
508	0763	0760		
509	0764	0754	0755	
510	0132	0753		
511	0133	0758		
512	0134	0762		
520	0754	0766	0767	0771

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

LABEL	DEFINED	REFERENCES		
521	0755	0773		
522	0757	0775	0780	0786
523	0756	0774		

524	C778	C776		
525	C798	0778	C784	C792
526	C799	C779		
527	C784	C781		
528	C800	C785		
529	C792	C787		
530	C135	0666		
531	0136	C667		
532	C137	C670		
533	C138	0671	C688	
534	C139	C673	C690	
535	C140	C677		
536	C142	0680		
537	C143	C682		
538	C144	C687		
539	C145	C692		
570	C146	C695		
571	C147	C693		
572	C148	C697		
573	C149	C699		
574	C150	C702		
576	C151	C705		
641	C152	C625		
642	C628	0627		
650	C153	C631		
651	C154	0801		
652	C155	C805		
653	C156	C803		
715	C535	0531		
716	0538	C534		
720	C510	C497		
721	C543	C539	C539	
730	C559	C563		
731	C570	C561		
732	C560	C555		
733	C157	C512		
850	C158	C514		
1001	0546	C544	C545	
1002	C555	C547		
1003	C554	C549		
1004	C553	C550		
1005	C556	0237	0556	
1020	C493	C165		
1021	C481	C167		
1022	C478	C163		
1111	0274	C244		
1112	C275	C274		
2001	C832	C827	C828	C829
2002	C831	C830		
2003	C834	C833		
4210	C075	C638		
4211	C076	C640		
5650	C141	C684		

ORIGINAL PAGE IS
OF POOR QUALITY

/ INPUT / SIZE CF PRCGRAM 0071C0 HEXADECIMAL BYTES PAGE 020

NAME	TAG		TYPE	ADD.	NAME	TAG		TYPE	ADD.	NAME	TAG		TYPE	ADD.	NAME	TAG		TYPE	ADD.
D	SFA		R*4	001E80	F	SF		R*4	001E84	G			R*4	N.R.	H	SF		R*4	001E88
I	SFA		I*4	001E8C	J	SF		I*4	001E90	K	SFA		I*4	001E94	N	SFA	C	I*4	000000
S	SF		R*4	001E98	X	SFA	C	R*4	0055F0	AA	SF		R*4	001E9C	AR	SF		R*4	001EA0
A1	SFA		R*4	002030	A2	S		R*4	001EA4	BB	S		R*4	001EA8	ER	SF		R*4	001EAC
B1	SFA		R*4	002044	CA	SF		R*4	001EB0	CB	SF		R*4	001EB4	CG		C	R*4	N.R.
CP	SF		R*4	001EB8	C1	SFA		R*4	002058	DX	S	C	R*4	000644	D1	SFA		R*4	00206C
FA	S		R*4	001EBC	FF	SF		R*4	001EC0	FN	SF	C	R*4	000000	HR	SF	C	R*4	000010
II	SF		I*4	001EC4	IJ	SF		I*4	001EC8	IK	SF		I*4	001ECC	IT	SFA		I*4	001ED0
IU	SF		I*4	001ED4	JJ		C	I*4	N.R.	JK		C	I*4	N.R.	KK			I*4	001ED8
K1	SF		I*4	001EDC	NK	SF	C	I*4	000008	NM		C	I*4	N.R.	NN	SF		I*4	001EE0
NT	SF		I*4	001EE4	N1	SF		I*4	001EE8	PI	FA	C	R*4	000000	RN	SF		C*8	003500
RX	SF		R*4	001EEC	RY	SF		R*4	001EF0	SB	SF		R*4	001EF4	SP	SF		R*4	001EF8
ST	SF		R*4	001EFC	UN		C	R*4	N.R.	US	SF	C	R*4	0007C0	VN		C	R*4	N.R.
VS	SF	C	R*4	0007FC	WN		C	R*4	N.R.	WS	SF	C	R*4	000838	W1	SF		R*4	001F00
W2	SF		R*4	001F04	W3	SF		R*4	001F08	XA	SF		R*4	001FCC	XN	SFA	C	R*4	000484
X1	SF	C	R*4	005DC0	YY	SF		R*4	001F10	Y1	SF	C	R*4	006590	Y2	SF		R*4	002080
ZX		C	R*4	N.R.	ZY		C	R*4	N.R.	ACL	F	C	R*4	000028	ALB		C	R*4	N.R.
BCL	F	C	R*4	000050	CCL	F	C	R*4	000078	CDF	SF	C	R*4	006D60	CHT	S	C	R*4	000050
CIN		C	R*4	N.R.	C20	SFA	C	R*4	000014	FFF	SF		R*4	001F14	HCL	F	C	R*4	000000
ICL	SFA		I*4	001F18	IJP	SF		I*4	001F1C	IMP		C	I*4	000000	INC	F	C	I*4	000000
IND		C	I*4	000000	IPR	SF		I*4	001F20	IST		C	I*4	000034	NNK	SF		I*4	001F24
NSP	SF		I*4	001F28	NUM	SF		I*4	001F2C	PHI	SFA		R*4	001F30	RZA	SF		R*4	001F34

```
   S13  SF      R*4  001F38      S23  SFA  C  R*4  000C53      S11  SF   C  R*4  000000      S12  SF   C  R*4  000700
   S22  SF   C  R*4  001770      S33  SF   C  R*4  002710      S34  SF   C  R*4  0036B0      S44  SF   C  R*4  004650
   TFN  SF      R*4  001F3C      TOL  S    C  R*4  000324      TOR  SF   C  R*4  0000C4      TCT  SF      R*4  001F40
   TPI       C  R*4    N.R.      TAU  SF      R*4  001F44      T*1  SF      R*4  001F48      UNR  SFA  C  R*4  00003C
   VNR  SFA  C  R*4  000040      WAV  F    C  R*4  000038      *C0  SF      R*4  001F4C      *C1  SF      R*4  001F50
   WNG       C  R*4    N.R.      WNR  SFA  C  R*4  000044      XCL  F    C  R*4  0000AC      XX2  SF      R*4  001F54
   XX3  SF      R*4  001F58      XX4  SF      R*4  001F5C      YCL  F    C  R*4  0000C8      ACLD S    C  R*4  000050
   ADLF SF      R*4  001F60      CINR SFA  C  R*4  000024      CNR6 S       R*4  001F64      CREC S    C  R*4  00000C
   CX21 SF      R*4  001F68      CX31 SF      R*4  001F6C      CX32 SF      R*4  001F70      DELD SF      R*4  002210
   DENS SFA     R*4  002224      DMAX SF      R*4  0029F4      DUM1 SF      R*4  002AC8      DUM2 SF      R*4  002898
   IALB SF      I*4  001F74      ICLD SF      I*4  001F78      IFC1 SFA  C  I*4  000018      IFC2 SF   C  I*4  00001C
   IFC3 SF   C  I*4  000020      IGND      C  I*4    N.R.      ILOC SF      I*4  001F7C      IMPJ SF   C  I*4  000008
   IMPK      C  I*4    N.R.      INDC SFA     I*4  001F80      IREC SFA  C  I*4  000004      ISKY FA      I*4  001F84
   ISCL SF      I*4  001F88      ISUN SFA     I*4  001F8C      KMAX SF   C  I*4  000030      MALB SFA     I*4  001F90
   NALB SF   C  I*4  000000      NCON S    C  I*4  000000      NMAX SF   C  I*4  000044      NSCA SF   C  I*4  000004
   NSCL SF   C  I*4  000000      NSTP SF      I*4  00202C      NTOT SF      I*4  002D40      NUMK SF   C  I*4  00001C
   OEXT SF      R*4  001F94      OSCA SF      R*4  001F98      PPHI SFA     R*4  001F9C      SBET SFA     R*4  001FA0
   SCTH SF   C  R*4  000014      SOLC SF   C  R*4  000000      SOLT      C  R*4    N.R.      SPHI SFA     R*4  001FA4
   STEP SFA     R*4  002054      SX11 SF      R*4  001FA8      SX12 SF      R*4  001FAC      SX33 SF      R*4  001FB0
   SX34 SF      R*4  001FB4      SZUR SF      R*4  001FB8      TEMP SF      R*4  002068      TCRT SFA  C  R*4  000194
   WSIG S    C  R*4  000004      WSPD SF      R*4  001FBC      WSUN SFA  C  R*4  000004      XANG SF      R*4  001FC0
   XBND SF   C  R*4  00000C      XCAP F       I*4  002EF8      XLO* SF      R*4  001FC4      ALBPT SFA    R*4  001FC8
   ALPHA SF     R*4  001FCC      ASECT SF     R*4  002F04      CLDEN F   C  R*4  000118      CLINP SF XF  R*4  000000
   CLCOD F   C  R*4  0000C8      CNTRX SF  C  R*4  000010      CNTRY SF  C  R*4  000060      CSECT SF     R*4  002F18
   DUMMY SF     R*4  002F2C      EDGEX SF  C  R*4  000080      EDGEY SF  C  R*4  000100      FACTR SF  C  R*4  000048
   FUNCT F  XF  R*4  000000      IAPAT S   C  I*4  000004      IDIST SFA    I*4  00308C      IFACE SF     I*4  001FD0
   ILOCT S      I*4  001FD4      INCLD SF  C  I*4  000008      INDIC SF  C  I*4  000004      INDCZ S      I*4  001FD8
   INPUT        I*4  001FDC      IRAND F   C  I*4  000000      IRBGD SFA C  I*4  000004      IRCLD SFA C  I*4  000000
   IRPAT SFA C  I*4  000000      ISPUT SF     I*4  001FE0      ITAPE S      I*4  0030D0      IUNIT SF     I*4  0030E4
   NCLD1 SFA C  I*4  000024      NSPUT SF     I*4  001FE4      NTCON SF     I*4  001FE8      SCALE SF     R*4  0030F8
   SIGMA        R*4    N.R.      SOLMU        R*4    N.R.      THEAR SFA C  R*4  000000      THDEG F   C  R*4  0000F0
   THINT SF     R*4  00310C      THRMS SF     R*4  001FEC      THSEP SFA    R*4  001FF0      THSER SFA C  R*4  000010
   TOTOZ SF     R*4  001FF4      TWSPD SF     R*4  001FF8      WAVEL        R*4    N.R.      WSIG2 SFA C  R*4  000008
   XFACE SF     R*4  001FFC      ARCOS    XF  R*4  000000      EXP      XF  R*4  000000      ALOG     XF  R*4  000000
   FRXPI#   XF  R*4  000000      SQRT     XF  R*4  000000      FRXPR#   XF  R*4  000000      COS      XF  R*4  000000
   SIN      XF  R*4  000000      ALBEDC SF XF R*4  000000      CLNANG SF    R*4  002000      COSBAR S     R*4  002004
   EXPFAC SFA   R*4  002008      FACTOR    C  R*4    N.R.      IAPATT SF    I*4  00200C      IBCOM# F XF  I*4  000000
   INDCOZ S     I*4  002010      INDICA S     I*4  00329C      INFLUX    C  I*4    N.R.      IRSPCT S  C  I*4  000008
   NCLCOD F  C  I*4  000000      NLAYER SFA C I*4  000000      POINTR SF C  R*4  00004C      RADCON SFA   R*4  002014
   RECANG SFA C R*4  0000C8      REFACT SF    C*8  002028      SCALHT SF    R*4  002018      SOLCON SF    R*4  00201C
   SOLDIR SF    R*4  003230      SOLPHI       R*4    N.R.      SOLSTD FA    R*4  003364      TAWSUN    C  R*4    N.R.
   THEAND SF    R*4  002020      THSINT SF    R*4  003370      TOLCLD SF C  R*4  000028      TRANS2 SF XF R*4  000000
   T*SIG2 SF    R*4  002024

                                   *****  COMMON INFORMATION  *****

   NAME OF COMMON BLOCK  *        *  SIZE OF BLOCK   007530 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
     S11      R*4   000000         S12      R*4   000700         S22      R*4   001770         S33      R*4   002710
     S34      R*4   0036B0         S44      R*4   004650         X        R*4   0055F0         X1       R*4   0050C0
     Y1       R*4   006590         COF      R*4   006060

   NAME OF COMMON BLOCK  * RMAP*  SIZE OF BLOCK   000150 HEXADECIMAL BYTES

                                                                                                 PAGE 021

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
     IRPAT    I*4   000000         IRBGD    I*4   000004         IRSPUT   I*4   000008         XBND     R*4   00000C
     CNTRX    R*4   000010         CNTRY    R*4   000060         EDGEX    R*4   000080         EDGEY    R*4   000100

   NAME OF COMMON BLOCK  * FREN*  SIZE OF BLOCK   000020 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
     FN       R*4   000000         WSIG     R*4   000004         WSIG2    R*4   000008         WNG      R*4   N.R.
     ZX       R*4   N.R.           ZY       R*4   N.R.

   NAME OF COMMON BLOCK  *IMPCRT*  SIZE OF BLOCK   000018 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
     IMP      I*4   000000         IMPK     I*4   N.R.           IMPJ     I*4   000008         TAWSUN   R*4   N.R.
     THSER    R*4   000010         SOTH     R*4   000014

   NAME OF COMMON BLOCK  *SFTLIT*  SIZE OF BLOCK   000004 HEXADECIMAL BYTES
```


ORIGINAL PAGE IS
OF POOR QUALITY

```
      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
       THEAR      R*4   000000

          NAME OF COMMON BLOCK  *   SUL*    SIZE OF BLOCK    000874 HEXADECIMAL BYTES

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
        NSCL      I*4   000000         *SUN     R*4   000004            US    R*4   0007C0            VS    R*4   0007FC
          *S      R*4   000838

          NAME OF COMMON BLOCK  *   PHOT*   SIZE OF BLOCK    00006C HEXADECIMAL BYTES

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
         CIN      R*4   N.R.             UN     R*4   N.R.              VN    R*4   N.R.              WN    R*4   N.R.
          JJ      I*4   N.R.           SOLT     R*4   N.R.           INCLD    I*4   000068

          NAME OF COMMON BLOCK  *   ATM*    SIZE OF BLOCK    0007D4 HEXADECIMAL BYTES

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
      NLAYER      I*4   000000           TCR    R*4   000004          TURT    R*4   000194           TOL    R*4   000324
          XH      R*4   000484            CX    R*4   000644

          NAME OF COMMON BLOCK  *   SCAT*   SIZE OF BLOCK    000020 HEXADECIMAL BYTES

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
           N      I*4   000000         INDIC    I*4   000004            JK    I*4   N.R.            IGND    I*4   N.R.

          NAME OF COMMON BLOCK  *  PARAM*   SIZE OF BLOCK    000048 HEXADECIMAL BYTES

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
         IND      I*4   000000          NSCA    I*4   000004            NK    I*4   000008          NUMK    I*4   00001C
        KMAX      I*4   000030           IST    I*4   000034           *AV    R*4   000038        FACTCR    R*4   N.R.
          NM      I*4   N.R.            NMAX    I*4   000044

          NAME OF COMMON BLOCK  *   GND*    SIZE OF BLOCK    000004 HEXADECIMAL BYTES

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
        NALB      I*4   000000           ALB    R*4   N.R.              CG    R*4   N.R.

          NAME OF COMMON BLOCK  *  CLPAR*   SIZE OF BLOCK    000198 HEXADECIMAL BYTES

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
      NCLCUD      I*4   000000        NCLD1     I*4   000004         CLOUD    R*4   000008

          NAME OF COMMON BLOCK  * CLEAIM*   SIZE OF BLOCK    000078 HEXADECIMAL BYTES

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
         INC      I*4   000000        TULCLD    R*4   000028          ACLD    R*4   000050

          NAME OF COMMON BLOCK  *  CREAD*   SIZE OF BLOCK    000140 HEXADECIMAL BYTES

                                                                                                                   PAGE 022

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
         FCL      R*4   000000           ACL    R*4   000028           BCL    R*4   000050           CCL    R*4   000078
         XCL      R*4   0000A0           YCL    R*4   0000C8         THDEG    R*4   0000F0         CLDEN    R*4   000118

          NAME OF COMMON BLOCK  *   RCVR*   SIZE OF BLOCK    00005C HEXADECIMAL BYTES

      VAR. NAME   TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
       IRCLD      I*4   000000          IREC    I*4   000004        RECANG    R*4   000008          CREC    R*4   00000C
          FR      R*4   000010           CZD    R*4   000014          IFC1    I*4   000018          IFC2    I*4   00001C
        IFC3      I*4   000020          CINR    R*4   000024           UNR    R*4   00003C           VNR    R*4   000040
         WNR      R*4   000044         FACTR    R*4   000046        PCINTR    R*4   00004C           CHT    R*4   000050
      INFLUX      I*4   N.R.             S2D    R*4   000058

          NAME OF COMMON BLOCK  *  CCNST*   SIZE OF BLOCK    000008 HEXADECIMAL BYTES
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
   VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.
      PI       R*4    000000           TPI      R*4    N.R.

        NAME OF COMMON BLOCK  *SCROLL*   SIZE OF BLOCK   000004 HEXADECIMAL BYTES

   VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.
     IRAND     I*4    000000

        NAME OF COMMON BLOCK  * SNCRM*   SIZE OF BLOCK   000004 HEXADECIMAL BYTES

   VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.
     SOLC      R*4    000000

        NAME OF COMMON BLOCK  *MAPCOM*   SIZE OF BLOCK   000008 HEXADECIMAL BYTES

   VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.
     NCCN      I*4    000000           IAPAT    I*4    000004

      LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR                PAGE 023

        10   003802                17   00397E               300   003A65                15   003870
        14   003078               151   003C60               200   003C6C               201   003DE4
         3   003CFA                 2   003F06                 4   004000                18   0040FC
      1111   00412C              1112   004162                 5   00417C                 9   0042EE
         6   004376                12   00443A                11   004638                 7   0046A4
        13   0047E0                 5   0047A6                41   0047C6 NR             20   0047CA
        21   0048EE                22   0049A5                30   004002                23   00482E
        24   00436E                25   004C30                 1   004C3A                35   004C3C
        38   004003                37   004DEA                36   004E0C                61   004F24
        60   004FA4                39   004F66                54   005056                55   0050BE
        33   00514E                28   00515A                27   005174                29   00516C
        19   0052AE                25   0052AC              1022   005300              1021   005320
      1020   005470               720   005558               715   00560E               716   005680
       721   0055A0              1001   0057CA              1004   0057E6              1003   0057EA
      1002   0057FE               752   0058EC               750   0058CA               751   0058E2
       142   005A54               144   005A60              1005   005A94                43   005AFE
       199   0060A8               500   0061AC               130   00620C               131   006334
       133   006424               132   006404               134   006404               442   00651E
       502   006770               501   006096               508   006588               509   006594
       524   006AA6               527   0068CE               529   006C78               520   006CC8
       480   006FB4                 8   00703E               198   007042 NR           2001   007088

  *OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

  *OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

  *STATISTICS*    SOURCE STATEMENTS =      835 ,PROGRAM SIZE =     29120

  *STATISTICS*   NO DIAGNOSTICS GENERATED

  ****** END OF COMPILATION ******

 LEVEL  21.6  (DEC 72)                          OS/360  FORTRAN H                              DATE  76.324/21.46.07

         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                            SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
   ISN 0002             SUBROUTINE SAMPLE(VSAMP,KK,ILPCN)
                  C**
                  C**      S U B R O U T I N E   S A M P L E
                  C**
                  C
                  C     THIS SUBROUTINE ACCUMULATES SAMPLES OF THE SCATTERING TRANSPORT
                  C     MATRIX CONTRIBUTIONS FOR EACH OF THE SPECIFIED SOLAR DIRECTIONS.
                  C     THE SCATTERING TRANSPORT MATRIX ELEMENTS ARE THE (HYPOTHETICAL)
                  C     VALUES WHICH WOULD BE OBSERVED IF SCATTERING INTO THE SPECIFIED
                  C     SOLAR ANGLE DID OCCUR MULTIPLIED BY THE PROBABILITY OF OCCURENCE.
                  C
                  C     CIN(6)=(1,2,3) POSITION CO-ORDS OF PHOTON, (4,5,6) DIR. COS OF ITS
                  C          PATH          COMMON/PHOT/
                  C     NSLL= NUMBER OF SOLAR ANGLES  SAMPLED (INPUT)       COMMON/SCL/
                  C     KK= INDICATOR OF WHETHER PRESENT SPECTRAL LINE IS UPPER (KK=2) OR
                  C         LOWER (KK=1) OF A LINE PAIR (INPUT)      COMMON/SCAT/
                  C     UN = DIRECTION COSINES OF NORMAL TO PREVIOUS SCATTERING PLANE
                  C     VN           COMMON/PHOT/
                  C     WN
                  C     JK= INDICATOR OF SCATT. SPECIES INFORMATION LOCATION (INPUT)
```

```
                 C            COMMON/SCAT/
                 C      N= NUMBER OF ANGLES FOR WHICH MATRIX ELEMENTS ARE DEFINED   (INPUT)
                 C            COMMON/SCAT/
                 C      TCL(NLAYER)= CROSS SECTION *DENSITY OF SCATTERERS IN EACH
                 C             LAYER        COMMON/ATM/
                 C      INDIC= SCATTERING SPECIES INDICATOR VECTOR (INPUT)     COMMON/SCAT
                 C      JL= ATMOSPHERIC LAYER CONTAINING CURRENT PHOTON    COMMON/PHOT/
                 C      JL= ATMOSPHERIC LAYER CONTAINING CURRENT PHOTON    COMMON/PHOT/
                 C      NLAYER= NUMBER OF ATMOSPHERIC LAYERS (INPUT)   COMMON/ATM/
                 C      ICND= COUNTER OF NUMBER OF GROUND SCATTERINGS THIS PHOTON HAS
                 C            SUFFERED       COMMON/SCAT/
                 C      SCUT(16)= CUMULATIVE SCATTERING TRANSPORT MATRIX       COMMON/PHOT/
ISN 0003                DIMENSION VSAMP(4,5,3,1,50),FF(50)
ISN 0004                DIMENSION SSIN(16),SS(16),S(6),ST(16)
ISN 0005                DIMENSION CURR(6)
ISN 0006                DIMENSION CCUT(6)
ISN 0007                COMMON/GNDHIT/ISCAT,IRCCD
ISN 0008                COMMON/SCL/NSCL,WSUN(11,15,3),US(15),VS(15),WS(15)
ISN 0009                COMMON/IMPORT/IMP,IMPX,IMPJ,TAWSUN,THSDR,SDTH
ISN 0010                COMMON/PHOT/CIN(6),UN,VN,WN,JL,SCUT(16),INCLD
ISN 0011                COMMON/SCAT/N,INDIC(60),JK,ICND
ISN 0012                COMMON/GND/NALB,ALB(50),CG(2)
ISN 0013                COMMON/WT/WEIGHT
ISN 0014                COMMON/CLPAR/NCLOUD,NCLD1,CLCLD(10,10)
ISN 0015                COMMON/LRONTE/COORD(6),CLCCRD(6)
ISN 0016                COMMON/FIL/AJEN
                 C
                 C
ISN 0017                DO 4 I=1,NALB
ISN 0018                FF(I)=ALB(I)
ISN 0019              4 CONTINUE
ISN 0020                IS=2+IUPDN
                 C
                 C      ARE WE NOW IN A CLOUD
                 C
ISN 0021                IF(INCLD.EQ.0)GO TO 10
                 C
                 C      YES, IN A CLOUD
                 C
ISN 0023                ICL=INCLD
ISN 0024                DO 11 IJ=1,3
ISN 0025                CLCORD(IJ)=CIN(IJ)
ISN 0026             11 CURR(IJ)=CIN(IJ)
ISN 0027                INDC=+1
ISN 0028                CALL TRANS1(ICL,INDC)
ISN 0029                GO TO 12
ISN 0030             10 ICL=NCLD1
ISN 0031                DO 13 IJ=1,3
ISN 0032             13 CLCRD(IJ)=CIN(IJ)
ISN 0033             12 CONTINUE
ISN 0034                DO 1 I=1,NSCL
                 C
                 C      GET COSINE OF SCATT. ANGLE FOR SCATT INTO SOLAR DIRECTION
                 C
ISN 0035                COSAN=CIN(4)*WSUN(ICL,I,1)+CIN(5)*WSUN(ICL,I,2)+CIN(6)*WSUN(ICL,I,
               .3)
ISN 0036                BETA=ARCOS(COSAN)
ISN 0037                DO 23 IJ=1,3
```

PAGE-002

```
ISN 0038                IJP=IJ+3
ISN 0039             23 COORD(IJP)=WSUN(NCLD1,I,IJ)
ISN 0040                IF(INCLD.EQ.0)GO TO 14
ISN 0042                DO 15 IJ=1,3
ISN 0043                IJP=IJ+3
ISN 0044                CLCORD(IJ)=CURR(IJ)
ISN 0045             15 CLCORD(IJP)=WSUN(ICL,I,IJ)
ISN 0046             14 CONTINUE
ISN 0047                CALL FIXALL(WSUN(ICL,I,1),WSUN(ICL,I,2),WSUN(ICL,I,3),CIN(4),CIN(5
               .),CIN(6),UN,VN,WN,PSI,A1,B1,C1)
ISN 0048                CALL ROTATE(SCUT,SSIN,PSI)
                 C
                 C      COMPUTE SCATTERING MATRIX ELEMENTS FOR A SCATTERING INTO THE SUN
                 C
ISN 0049                IF(ISCAT.EQ.0)GO TO 31
                 C             GROUND SCATTERING SAMPLE
ISN 0051                DO 40 IJ=1,3
ISN 0052                IJP=IJ+3
ISN 0053             40 CCUT(IJP)=WSUN(ICL,I,IJ)
```

```
ISN 0054              IF(IRCOD.EQ.0)CALL LAMBRT(CCUT,S,1)
ISN 0056              IF(IRCOD.NE.0)CALL GENGND(CCUT,CIN,IRCOD,S,1)
ISN 0058              CALL GENSCA(SSIN,SS,S,1)
ISN 0059              GO TO 30
ISN 0060           31 CONTINUE
                C     RAYLEIGH SCATTERING
                C
ISN 0061              IF(INDIC(JK).NE.0)GO TO 2
ISN 0063              CB=COSAN
                C
                C     COMPUTE TRANSFORMED SCATT. MATRIX FOR RAYLEIGH SCATT.
                C
ISN 0064              CALL SCATRA(SSIN,SS,CB,1)
ISN 0065              GO TO 30
                C     COMPUTE SCATTERING MATRIX ELEMENTS FOR OTHER TYPES OF SCATT.
                C
ISN 0066            2 CALL ELEMTS(BETA,S,1)
                C
                C     TRANSFORM SCATT. MATRIX
                C
                C     MIE SCATTERING
ISN 0067              IF(INDIC(JK).NE.3)CALL SCATMI(SSIN,SS,S,1)
                C
                C     OTHER TYPES OF SCATT.
                C
ISN 0069              IF(INDIC(JK).EQ.3)CALL GENSCA(SSIN,SS,S,1)
                C
                C     COMPUTE ATTENUATION ALONG PATH TO SUN
                C     FIRST, GET OPTICAL PATH LENGTH TO SUN
                C
ISN 0071           30 CONTINUE
ISN 0072              CALL SEPSOL(TAUS)
ISN 0073              IF(TAUS.GT.150.)TAUS=150.
ISN 0075              TAWSUN=TAUS
ISN 0076              FR=EXP(-TAUS)
ISN 0077              FR=FR*WEIGHT
ISN 0078              DO 3 IALB=1,NALB
ISN 0079              DO 3 L=1,4
                C
                C     SAMPLE
                C
ISN 0080              ST(L)=SS(L)
ISN 0081              ST(L)=ST(L)*FF(IALB)
ISN 0082            3 VSAMP(L,I,IS,KK,IALB)= VSAMP(L,I,IS,KK,IALB)+FR*ST(L)/ADEN
ISN 0083            1 CONTINUE
ISN 0084              RETURN
ISN 0085              END
```

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****      PAGE 003

SYMBOL   INTERNAL STATEMENT NUMBERS
I        0017  0018  0016  0034  0035  0035  0035  0039  0045  0047  0047  0047  0053  0082  0082
L        0079  0080  0080  0081  0081  0082  0082  0082
N        0011
S        0014  0054  0056  0058  0066  0067  0069
A1       0047
B1       0047
CB       0063  0064
CG       0012
C1       0047
FF       0013  0019  0081
FR       0076  0077  0077  0082
IJ       0024  0025  0025  0026  0026  0031  0032  0032  0037  0038  0039  0042  0043  0044  0044  0045  0051  0052  0053
IS       0020  0082  0082
JJ       0010
JK       0011  0061  0067  0069
KK       0012  0082  0032
SS       0004  0058  0064  0067  0069  0080
ST       0004  0080  0081  0081  0082
UN       0010  0047
US       0008
VN       0010  0047
VS       0008
WN       0010  0047
WS       0008
ALB      0012  0018
CIN      0010  0025  0026  0032  0035  0035  0035  0047  0047  0047  0056
EXP      0076
ICL      0023  0028  0030  0035  0035  0035  0045  0047  0047  0047  0053
IJP      0028  0039  0043  0045  0052  0053
```

```
IMP      0009
PSI      0047   0043
ADEN     0016   0062
BETA     0036   0066
COUT     0066   0053   0054   0056
CURR     0005   0026   0044
IALB     0078   0061   0082   0082
IGND     0011
IMPJ     0009
IMPX     0009
INCC     0027   0028
NALB     0012   0017   0076
NSUL     0068   0034
SOTH     0009
SOUT     0010   0048
SSIN     0024   0048   0058   0064   0067   0069
TAUS     0072   0073   0073   0075   0076
WSUN     0068   0035   0035   0035   0039   0045   0047   0047   0047   0053
ARCOS    003E
CLCUD    0014
COURD    0015   0032   0039
COSAN    0035   0036   0063
INCLD    0010   0021   0022   0040
INDIC    0011   0061   0067   0065
IRCOD    0007   0054   0056   0056
ISCAT    0007   0049
IUPON    0002   0021
NCLDI    0014   0030   0039
THSBR    0009
VSAMP    0002   0003   0082   0082
CLCURD   0015   0025   0044   0045
ELEMIS   0066
FIXALL   0047
GENGND   0056
GENSCA   0036   0069
LAMBRT   0054
NCLDUD   0014
ROTATE   0048
SAMPLE   0002
SCATMI   0067
SCATRA   0064
SEESOL   0072
TAWSUN   0009   0075
TRANSI   0026
WEIGHT   0013   0077
```

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 004

LABEL  DEFINED  REFERENCES
  1    0063     0034
  2    0066     0051
  3    0082     0078   0079
  4    0019     0017
 10    0030     0021
 11    0026     0024
 12    0033     0029
 13    0032     0031
 14    0046     0040
 15    0049     0042
 23    0039     0037
 30    0071     0059   0065
 31    0060     0049
 40    0053     0051
```

```
                  /  SAMPLE  /   SIZE OF PROGRAM 000945 HEXADECIMAL BYTES PAGE 005

 NAME  TAG   TYPE  ADD.      NAME  TAG   TYPE  ADD.      NAME  TAG   TYPE  ADD.      NAME  TAG   TYPE  ADD.
    I  SFA   I*4   000150       L  SF    I*4   000154       N     C  I*4     N.R.       S  SFA   R*4   0001A0
   AI  SFA   R*4   000158      BI  SFA   R*4   00015C      CB  SFA   R*4   000160      CG     C  R*4     N.R.
   CI  SFA   R*4   000164      FF  SF    R*4   0001B8      FR  SF    R*4   000168      IJ  SF    I*4   00016C
   IS  SF    I*4   000170      JJ     C  I*4     N.R.      JK     C  I*4   000018      KK  F     I*4   000174
   SS  SFA   R*4   000280      ST  SF    R*4   000200      UN  SFA C R*4   000018      LS     C  R*4     N.R.
   VN  SFA C R*4   00001C      VS     C  R*4     N.R.      WN  SFA C R*4   000020      WS     C  R*4     N.R.
  ALB  F   C R*4   000004     CIN  SFA C R*4   000000     ICL  SFA   I*4   000178     IJP  SF    I*4   00017C
  IMP     C  I*4     N.R.     PSI  SFA   R*4   000180    ADEN  F   C R*4   000000    BETA  SFA   R*4   000184
 COUT  SFA   R*4   000300    CURR  SF    R*4   000318    IALB  SF    I*4   000188    IGND     C  I*4     N.R.
 IMPJ     C  I*4     N.R.    IMPX     C  I*4     N.R.    INCC  SFA   I*4   00018C    NALB  F   C I*4   000000
 NSOL  F   C I*4   000000    SOTH     C  R*4     N.R.    SOUT  SFA C R*4   000028    SSIN  SFA   R*4   000330
```

```
TAUS   SFA      R*4  000190     WSUN   SFA  C  R*4  000004     CLOUD       C  R*4    N.R.      CCCRD  S    C  R*4  000000
CCSAN  SFA      R*4  000194     INCLD  F    C  I*4  000068     INDIC       C  I*4  000004      IRCCD  SFA  C  I*4  000004
ISCAT        C  I*4  000000     IOPON  F       I*4  000198     NCLLI  F    C  I*4  000004      THSER       C  R*4    N.R.
VSAMP  SF   XR  R*4  000000     EXP        XF  R*4  000000     ARCOS      XF  R*4  000000      CLCCRD S    C  R*4  000018
ELENTS SF   XF  R*4  000000     FIXALL SF  XF  R*4  000000     GENGND SF  XF  R*4  000000      GENSCA SF  XF  R*4  000000
LAMENT SF   XF  I*4  00000C     NCLCOD      C  I*4    N.R.     ROTATE SF  XF  R*4  000000      SAMPLE         R*4  00019C
SCATMI SF   XF  R*4  000000     SCATRA SF  XF  R*4  000000     SEESOL SF  XF  R*4  000000      TAWSUN S    C  R*4  00000C
TRANSI SF   XF  R*4  000000     WEIGHT F    C  R*4  000000

                                ***** COMMON INFORMATION *****

NAME OF COMMON BLOCK *GNGHIT*  SIZE OF BLOCK  000008 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  ISCAT     I*4   000000        IRCCD     I*4   000004

NAME OF COMMON BLOCK *  SOL*  SIZE OF BLOCK  000874 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  NSOL      I*4   000000        WSUN      R*4   000004        US        R*4    N.R.         VS        R*4    N.R.
  WS        R*4    N.R.

NAME OF COMMON BLOCK *IMFCRT*  SIZE OF BLOCK  000018 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  IMP       I*4    N.R.         IMFK      I*4    N.R.         IMFJ      I*4    N.R.         TAWSUN    R*4   00000C
  THSER     R*4    N.R.         SOTH      R*4    N.R.

NAME OF COMMON BLOCK *  FFUT*  SIZE OF BLOCK  00006C HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  CIN       R*4   000000        UN        R*4   000018        VN        R*4   00001C        WN        R*4   000020
  JJ        I*4    N.R.         SOUT      R*4   000028        INCLD     I*4   000068

NAME OF COMMON BLOCK *  SCAT*  SIZE OF BLOCK  000020 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  N         I*4    N.R.         INDIC     I*4   000004        JK        I*4   000018        IGND      I*4    N.R.

NAME OF COMMON BLOCK *   GND*  SIZE OF BLOCK  000004 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  NALB      I*4   000000        ALB       R*4   000004        CG        R*4    N.R.

NAME OF COMMON BLOCK *    WT*  SIZE OF BLOCK  000004 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  WEIGHT    R*4   000000

NAME OF COMMON BLOCK * CLPAR*  SIZE OF BLOCK  000198 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  NCLCOD    I*4    N.R.         NCLCI     I*4   000004        CLOUD     R*4    N.R.

NAME OF COMMON BLOCK *ORCNTE*  SIZE OF BLOCK  000030 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  CCCRD     R*4   000000        CLCCRD    R*4   000018

                                                                                                        PAGE 006

NAME OF COMMON BLOCK *   FIL*  SIZE OF BLOCK  000004 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  ACEN      R*4   000000

LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR             PAGE 007
   4   0004CC                11   0004AE               13   0004DC               13   0004EC
```

ORIGINAL PAGE IS OF POOR QUALITY

```
  12  CCC4FE         23  0005EA         15  CCC61A         14  0C0632
  40  CCCOC6         31  00L730          2  0CC75C         30  00C7AE
   3  CCC8E8          1  C0CBAC

*OPTIONS IN EFFECT*      NAME= MAIN,OPT=02,LINECNT=92,SIZE=0000K,
*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*     SOURCE STATEMENTS =      64 ,PROGRAM SIZE =      2374
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                                  161K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                  OS/360  FORTRAN H                        DATE  76.324/21.46.18

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=92,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
  ISN 0002          SUBROUTINE SEESOL(TAUS)
  ISN 0003          DIMENSION AS(10),IENTER(10)
  ISN 0004          DIMENSION CDIST(10),JENTER(10),ENT(10,3),DIST(10),EXT(10,3)
  ISN 0005          COMMON/PHOT/CIN(6),UN,VN,WN,JJ,SCLT(16),INCLD
  ISN 0006          COMMON/ATM/NLAYER,TOR(100),TORT(100),TOL(100),XH(100),DX(100)
  ISN 0007          COMMON/CLPAR/NCLOUD,NCLD1,CLCLD(10,10)
  ISN 0008          COMMON/CRDNTE/COORD(6),CLCORD(6)
  ISN 0009          COMMON/CLDATM/INC(10),TOLCLD(10),ACLD(10)
  ISN 0010          DTAU1=0.
  ISN 0011          DTAU2=0.
  ISN 0012          TAUS=0.
              C
              C     ARE WE IN A CLOUD NOW
  ISN 0013          IF(INCLD.EQ.0)GO TO 10
              C
              C     YES, IN A CLOUD.  GET OPTICAL DISTANCE OUT
              C       ASSUME CLCORD HAS BEEN SET UP BY CALLING ROUTINE
              C
  ISN 0015          CALL CLOUT(INCLD,NOUT,CDIST,EXT)
  ISN 0016          DTAU1=CDIST(INCLD)*TOLCLD(INCLD)
  ISN 0017       10 CONTINUE
              C
              C     CONTRIBUTION OF OVERLYING AMBIANT ATMOSPHERIC LAYERS
              C
  ISN 0018          DTAU=(TORT(NLAYER)-TORT(JJ))/CCCRD(6)
              C
              C     CONTRIBUTION OF CURRENT AMBIANT ATMOSPHERIC LAYER
              C
  ISN 0019          DTAU=DTAU+(XH(JJ)-COORD(3))*TOL(JJ)/CCORD(6)
  ISN 0020          PATH=(XH(NLAYER)-COORD(3))/CCORD(6)
  ISN 0021          IF(NCLOUD.EQ.0)GO TO 20
              C
              C     CHECK CLOUD SPHERES ENTERED ALONG PATH
              C
  ISN 0023          CALL CLENTR(PATH,AS,IENTER,NENTER)
  ISN 0024          IF(NENTER.EQ.0)GO TO 20
  ISN 0026          CALL SDIST(NENTER,IENTER,JENTER,ENT,DIST,NPLANE)
  ISN 0027          IF(NENTER.EQ.0)GO TO 20
  ISN 0029          DO 30 ICLD=1,NENTER
  ISN 0030          INOC=-1
  ISN 0031          IJ=JENTER(ICLD)
  ISN 0032          CALL TRANS(IJ,INOC)
  ISN 0033          CALL CLOUT(IJ,NOUT,CDIST,EXT)
  ISN 0034          DTAU2=DTAU2+(CDIST(IJ)-DIST(IJ))*TOLCLD(IJ)
  ISN 0035       30 CONTINUE
  ISN 0036       20 TAUS=DTAU+DTAU1+DTAU2
  ISN 0037          RETURN
  ISN 0038          END

            *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****       PAGE 002

SYMBOL   INTERNAL STATEMENT NUMBERS
AS       0003  0023
DX       0006
IJ       0031  0032  0033  0034  0034  0034
JJ       0005  0018  0019  0019
UN       0005
VN       0005
WN       0005
XH       0006  0019  0020
CIN      0005
```

ORIGINAL PAGE IS
OF POOR QUALITY

ENT	0014	0026				
EXT	0014	0015	0033			
INC	0005					
TOL	0006	0019				
TOR	0006					
ACLD	0009					
DIST	0014	0026	0034			
DTAU	0018	0019	0019	0036		
ICLD	0029	0031				
INCC	0030	0032				
NOUT	0015	0033				
PATH	0020	0023				
SOUT	0005					
TAUS	0012	0012	0036			
TURT	0016	0018	0018			
CDIST	0014	0015	0016	0033	0034	
CLOUD	0007					
CLOUT	0015	0033				
COORD	0008	0019	0019	0019	0020	0020
DTAU1	0010	0016	0036			
DTAU2	0011	0024	0034	0036		
INCLD	0015	0013	0015	0016	0016	
NCLD1	0007					
SDIST	0026					
TRANS	0032					
CLCORD	0008					
CLENTR	0023					
IENTER	0013	0023	0026			
JENTER	0024	0026	0031			
NCLOUD	0007	0021				
NENTER	0023	0024	0026	0027	0029	
NLAYER	0016	0018	0020			
NPLANE	0026					
SEESCL	0032					
TOLCLD	0005	0016	0034			

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****   PAGE 003

LABEL	DEFINED	REFERENCES		
10	0017	0013		
20	0036	0021	0024	0027
30	0035	0029		

/ SEESCL /   SIZE OF PROGRAM 00048E HEXADECIMAL BYTES PAGE 004

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
AS	SFA	R*4	0001CC	DX	C	R*4	N.R.	IJ	SFA	I*4	0000DC	JJ	F C	I*4	000C24
CN	C	R*4	N.R.	VN	C	R*4	N.R.	*N	C	R*4	N.R.	XH	F C	R*4	000484
CIN	C	R*4	N.R.	ENT	SFA	R*4	000134	EXT	SFA	R*4	0001AC	INC	C	I*4	N.R.
TOL	F C	R*4	000324	TOR	C	R*4	N.R.	ACLD	C	R*4	N.R.	DIST	SFA	R*4	000224
DTAU	SF	R*4	0000E0	ICLD	SF	I*4	0000E4	INCC	SFA	I*4	0000E8	NOUT	SFA	I*4	0000EC
PATH	SFA	R*4	0000FC	SOUT	C	R*4	N.R.	TAUS	S	R*4	0000F4	TORT	F C	R*4	000194
CDIST	SFA	R*4	00024C	CLOUD	C	R*4	N.R.	CLOUT	SF XF	R*4	000000	COORD	F C	R*4	000000
DTAU1	SF	R*4	0000F8	DTAU2	SF	R*4	0000FC	INCLD	SFA C	I*4	000068	NCLD1	C	I*4	N.R.
SDIST	SF XF	R*4	000000	TRANS	SF XF	R*4	000000	CLCORD	C	R*4	N.R.	CLENTR	SF XF	R*4	000000
IENTER	SFA	I*4	000274	JENTER	SFA	I*4	00029C	NCLOUD	C	I*4	000000	NENTER	SFA	I*4	000100
NLAYER	F C	I*4	000000	NPLANE	SFA	I*4	000104	SEESCL		R*4	0001C8	TOLCLD	F C	R*4	000028

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * PHOT* SIZE OF BLOCK 00006C HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
CIN	R*4	N.R.	CN	R*4	N.R.	VN	R*4	N.R.	*N	R*4	N.R.
JJ	I*4	000024	SOUT	R*4	N.R.	INCLD	I*4	000068			

NAME OF COMMON BLOCK * ATM* SIZE OF BLOCK 0007D4 HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
NLAYER	I*4	000000	TOR	R*4	N.R.	TORT	R*4	000194	TOL	R*4	000324
XH	R*4	000484	DX	R*4	N.R.						

NAME OF COMMON BLOCK * CLPAR* SIZE OF BLOCK 000198 HEXADECIMAL BYTES

```
 VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
 NCLCUD      I*4   000000        NCLD1      I*4   N.R.          CLOUD      R*4   N.R.

      NAME OF COMMON BLOCK  *CRCNTE*   SIZE OF BLOCK    000030 HEXADECIMAL BYTES

 VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
 CCCRD       R*4   000000        CLCCRD     R*4   N.R.

      NAME OF COMMON BLOCK  *CLDATM*   SIZE OF BLOCK    000078 HEXADECIMAL BYTES

 VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
 INC         I*4   N.R.          TCLCLD     R*4   000028        ACLD       R*4   N.R.

   LABEL   ADDR          LABEL   ADDR          LABEL   ADDR          LABEL   ADDR          PAGE 005

     10  00035C            30  00043E            20  000442

*OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

*STATISTICS*     SOURCE STATEMENTS =     37 ,PROGRAM SIZE =     1166

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                              177K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                 OS/360  FORTRAN H                         DATE  76.324/21.46.29

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
      ISN 0002              SUBROUTINE TRACK(IOUT,ISCAT,IX)
      ISN 0003              DIMENSION CINT(6)
      ISN 0004              DIMENSION IENTER(10),DIST(10),AS(10),ENT(10,3),CDIST(10),EXT(10,3)
      ISN 0005              COMMON/TST/ITEST
      ISN 0006              COMMON/PHCT/CIN(6),UN,VN,WN,JJ,SCLT(16),INCLD
      ISN 0007              COMMON/ATM/NLAYER,TOR(100),TCRT(100),TOL(100),XH(100),DX(100)
      ISN 0008              COMMON/GND/NALB,ALB(50),CG(2)
      ISN 0009              COMMON/CLFAR/NCLOUD,NCLD1,CLCUD(10,10)
      ISN 0010              COMMON/CRCNTE/CCCRD(6),CLCCRD(6)
      ISN 0011              COMMON/CLDATM/INC(10),TCLCLD(10),ACLD(10)
                      C
      ISN 0012              EPSS=5.E-06
                      C     CHOOSE A NEW OPTICAL PATH LENGTH
                      C
      ISN 0013              CALL RANDU(IX,IY,XX)
      ISN 0014              IX=IY
      ISN 0015              PT=-ALOG(XX)
      ISN 0016              PTI=PT
      ISN 0017           10 CONTINUE
      ISN 0019              IF(ITEST.EQ.0)GO TO 803
      ISN 0020              WRITE(6,804)PT,PTI,INCLD,(CIN(IJP),IJP=1,6)
      ISN 0021          804 FORMAT(1H0,20X,'PT=',E14.7,2X,'PTI=',E14.7,2X,'INCLD=',I2/
                           *1H ,20X,'CIN=',6(2X,E14.7))
      ISN 0022          803 CONTINUE
      ISN 0023              PTI=PT
      ISN 0024              IF(INCLD.GT.0)GO TO 20
                      C
                      C     WE ARE NOT IN A CLOUD
                      C
      ISN 0026              GNDHT=0.
      ISN 0027              TCLD=0.
      ISN 0028              TPHT=XH(NLAYER)
      ISN 0029              DO 31 I=1,6
      ISN 0030           31 CCCRD(I)=CIN(I)
                      C
                      C     CAN WE ENTER A CLOUD ALONG THIS DIRECTION
                      C
      ISN 0031              PTH=1500.
      ISN 0032              IF(NCLCLD.LE.0)GO TO 32
      ISN 0034              CALL CLENTH(PTH,AS,IENTER,NENTER)
      ISN 0035              IF(NENTER.LE.0)GO TO 32
      ISN 0037              CALL TDIST(AS,NENTER,IENTER,PTH,DIST,ENT,NPLANE,IENT)
      ISN 0038              IF(IENT.EQ.0)GO TO 32
      ISN 0040              PTHMX=DIST(IENT)
      ISN 0041              IBND=+1
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                 C      IBND KEEPS TRACK OF THE TYPE OF BOUNDARY LIKELY TO BE ENCOUNTERED
                 C           = 0 BOUNDARY OF AMBIANT ATMOSPHERE
                 C           = +1 ENTERING CLOUD FROM AMBIANT ATMOSPHERE
                 C           =-1 EXACT BOUND FOR EXITING CLOUD
                 C           =-2 APPROXIMATE BOUND FOR EXITING CLOUD
ISN 0042                GO TO 40
ISN 0043             32 CONTINUE
                 C
                 C      WE CANNOT ENTER A CLOUD ALONG THIS DIRECTION
                 C
                 C
                 C           QUICK LOOK (ESPECIALLY FOR THIN ATMOSPHERES )
                 C
ISN 0044                IF((CIN(6).GT.0.).AND.(PT.GE.((TCRT(NLAYER)-TCRT(JJ)+TCR(JJ))
                       */CIN(6))))GO TO 401
ISN 0046                PATH=-CIN(3)/CIN(6)
ISN 0047                IF((CIN(6).LT.0.).AND.(-PT.LE.(TCRT(JJ)/CIN(6))))GO TO 46
ISN 0049                PATH=0.
ISN 0050                PTHMX=1E00.
ISN 0051                IBND=0
ISN 0052                GO TO 40
ISN 0053             20 CONTINUE
ISN 0054                TCLD=TCLCLD(INCLD)
ISN 0055                DO 22 I=1,6
ISN 0056             22 CLCORD(I)=CIN(I)
                 C
                 C      WE ARE IN A CLOUD SPECIFIED BY INCLD
                 C
                 C      HOW FAR MUST WE GO TO GET OUT
                 C
                 C      ASSUME WE WILL NOT GET OUT OF CLOUD AND CORRECT LATER
                 C
ISN 0057                PTHMX=2.*CLCLD(INCLD,5)
```



```
ISN 0058                IBND=-2
ISN 0059             21 CONTINUE
ISN 0060                GNDHT=CLOUD(INCLD,3)
ISN 0061                TPHT=XH(NLAYER)-CLOUD(INCLD,3)
ISN 0062             40 CONTINUE
ISN 0063                PTH=0.
                 C
                 C      IS PHOTON GOING UP OR DOWN
                 C
ISN 0064                IF(CIN(6).GE.0.)GO TO 4
                 C
                 C      PHOTON IS GOING DOWN
ISN 0066                HT=CIN(3)+GNDHT
ISN 0067                TGND=-HT/CIN(6)
ISN 0068                PTHMX=AMIN1(TGND,PTHMX)
ISN 0069                IF(PTHMX.EQ.TGND)IBND=0
ISN 0071                EPS=EPSS*PTHMX
                 C
                 C      NOW TRACK DOWNWARDS UNTILL WE GET TO PT OR PTHMX,
                 C      WHICHEVER COMES FIRST
                 C
ISN 0072                W=-CIN(6)
ISN 0073                XLO=0.
ISN 0074                IF(JJ.NE.1)XLO=XH(JJ-1)
ISN 0076                DPTH=(CIN(3)+GNDHT-XLO)/W
ISN 0077                DPT=DPTH*(TCL(JJ)+TCLD)
ISN 0078                J=JJ
ISN 0079                IF(DPT.GE.PT)GO TO 44
ISN 0081                IF((DPTH+EPS).GE.PTHMX)GO TO 45
ISN 0083                IF(JJ.EQ.1)GO TO 99
ISN 0085                PT=PT-DPT
ISN 0086                PTH=DPTH
ISN 0087                JJM=JJ-1
ISN 0088                DO 43 IJ=1,JJM
ISN 0089                J=JJM-IJ+1
ISN 0090                DPTH=DX(J)/W
ISN 0091                DPT=DPTH*(TCL(J)+TCLD)
ISN 0092                IF(DPT.GE.PT)GO TO 44
ISN 0094                IF((DPTH+PTH+EPS).GE.PTHMX)GO TO 45
ISN 0096                PT=PT-DPT
ISN 0097                PTH=PTH+DPTH
ISN 0098             43 CONTINUE
                 C
```

```
                  C     IF WE GET TO THIS POINT WE HAVE MADE AN ERROR
                  C
ISN 0099                GO TO 99
ISN 0100             44 CONTINUE
                  C
                  C     WE HAVE USED UP ALL OF OUR PT
                  C
ISN 0101                IF(DPT.LE.0.)GO TO 99
ISN 0103                PATH=PTH+PT/DPT*DPTH
ISN 0104                PATH=AMIN1(PATH,PTHMX)
ISN 0105                IF(PATH.NE.PTHMX)GO TO 441
ISN 0107                GO TO 45
ISN 0108            441 CONTINUE
ISN 0109                PT=0.
                  C
                  C     UPDATE ALONG PATH
ISN 0110                GO TO 50
ISN 0111             45 CONTINUE
                  C
                  C     WE HAVE COME TO A BOUNDARY
                  C
ISN 0112                DPTH=(PTHMX-PTH)
ISN 0113                DPT=DPTH*(TCL(J)+TCLD)
ISN 0114                PT=PT-DPT
ISN 0115                PATH=PTH+DPTH
ISN 0116                IF(IBND.EQ.0)GO TO 46
                  C
                  C     THE BOUNDARY IS A CLOUD
                  C
                  C     IS BOUNDARY APPROXIMATE-- IF SO, UPDATE AND BACKTRACK
                  C
ISN 0118                IF(IBND.EQ.-2)GO TO 50
                  C     UPDATE THE PHOTON
ISN 0120                DO 47 JI=1,3
ISN 0121             47 CIN(JI)=CIN(JI)+PTHMX*CIN(JI+3)
ISN 0122                DO 471 IJ=1,NLAYER
ISN 0123                J=IJ

ISN 0124                IF(CIN(3).LT.XH(NLAYER))GO TO 472
ISN 0126            471 CONTINUE
ISN 0127            472 JJ=J
ISN 0128                IF(IBND.GT.0)GO TO 48
                  C
                  C     COMING OUT OF THE CLOUD
                  C
ISN 0130                DO 49 IJ=1,6
ISN 0131             49 CLCORD(IJ)=CIN(IJ)
ISN 0132                INDC=+1
ISN 0133                CALL TRANS(INCLD,INDC)
ISN 0134                DO 499 IJ=1,6
ISN 0135            499 CIN(IJ)=CCORD(IJ)
ISN 0136                CALL TRANS2(UN,VN,WN,UN,VN,WN,INCLD,INDC)
ISN 0137                INCLD=0
                  C
                  C     CONTINUE TRACKING
                  C
ISN 0138                GO TO 10
ISN 0139             48 CONTINUE
                  C
                  C     GOING INTO THE CLOUD
                  C     CHANGE COORDINATE SYSTEMS
                  C
ISN 0140                DO 488 IJ=1,6
ISN 0141            488 CCORD(IJ)=CIN(IJ)
ISN 0142                INDC=-1
ISN 0143                CALL TRANS(IENT,INDC)
ISN 0144                DO 489 IJ=1,6
ISN 0145            489 CIN(IJ)=CLCORD(IJ)
ISN 0146                INCLD=IENT
ISN 0147                CALL TRANS2(UN,VN,WN,UN,VN,WN,INCLD,INDC)
                  C
                  C     CONTINUE TRACKING
                  C
ISN 0148                GO TO 10
ISN 0149              4 CONTINUE
                  C
                  C     PHOTON GOING UP OR HORIZONTALLY
                  C
```

```
             C
             C     PHOTON TRAVELS HORIZONTALLY
             C
ISN 0152           J=JJ
ISN 0153           PTH=0.
ISN 0154           PTS=PT
ISN 0155           PATH=PT/(TCL(JJ)+TCLD)
ISN 0156           PT=0.
ISN 0157           IF(PATH.LE.PTHMX)GO TO 50
ISN 0159           PT=PTS
ISN 0160           GO TO 45
ISN 0161       401 CONTINUE
             C
             C     PHOTON GOING UP
             C
ISN 0162           TTOP=(TPHT-CIN(3))/CIN(6)
ISN 0163           PTHMX=AMIN1(TTOP,PTHMX)
ISN 0164           IF(PTHMX.EQ.TTOP)IBND=0
ISN 0166           PTH=0.
ISN 0167           DPTH=(XH(JJ)-(CIN(3)+GNDHT))/CIN(6)
ISN 0168           DPT=DPTH*(TCL(JJ)+TCLD)
ISN 0169           J=JJ
ISN 0170           IF(DPT.GE.PT)GO TO 44
ISN 0172           EPS=EPSS*PTHMX
ISN 0173           IF((DPTH+EPS).GE.PTHMX)GO TO 45
ISN 0175           PT=PT-DPT
ISN 0176           PTH=DPTH
ISN 0177           IF(JJ.EQ.NLAYER)GO TO 99
ISN 0179           JJP=JJ+1
ISN 0180           DO 402  JL=JJP,NLAYER
ISN 0181           J=JL
ISN 0182           DPTH=DX(J)/CIN(6)
ISN 0183           DPT=DPTH*(TCL(J)+TCLD)
ISN 0184           IF(DPT.GE.PT)GO TO 44
ISN 0186           IF((DPTH+PTH+EPS).GE.PTHMX)GO TO 45
ISN 0188           PT=PT-DPT
ISN 0189           PTH=PTH+DPTH
ISN 0190       402 CONTINUE
             C
             C     IF WE REACH THIS POINT, WE HAVE ERRED
ISN 0191           GO TO 99
ISN 0192        46 CONTINUE
             C
             C     BOUNDARY WHICH IS NOT A CLOUD BOUNDARY
ISN 0193           IF(CIN(6).GT.0.)GO TO 461
ISN 0195           DO 463 IJ=1,3
ISN 0196       463 CIN(IJ)=CIN(IJ)+PATH*CIN(IJ+3)
ISN 0197           JJ=1
             C
             C     GROUND BOUNDARY
             C
ISN 0198           ISCAT=1
ISN 0199           IF(INCLD.EQ.0)GO TO 462
             C
             C     IN A CLOUD
             C
ISN 0201           DO 464 IJ=1,6
ISN 0202       464 CLCORD(IJ)=CIN(IJ)
ISN 0203           INDC=+1
ISN 0204           CALL TRANS(INCLD,INDC)
ISN 0205           CG(1)=CCORD(1)
ISN 0206           CG(2)=CCORD(2)
ISN 0207           RETURN
ISN 0208       462 CONTINUE
ISN 0209           CG(1)=CIN(1)
ISN 0210           CG(2)=CIN(2)
ISN 0211           RETURN
ISN 0212       461 CONTINUE
             C
             C     PHOTON EXITS ATMOSPHERE
             C
ISN 0213           IOUT=1
ISN 0214           IF(ITEST.EQ.0)GO TO 810
ISN 0216           WRITE(6,811)IOUT,PT,PTI,PATH,PTHMX,PTH,DPTH,IBND,INCLD,JJ
ISN 0217           WRITE(6,812)(CIN(IPRT),IPRT=1,6)
ISN 0218       811 FORMAT(1H0,2X,'IOUT=',I2,'PT=',E14.6,'PTI=',E14.7,'PATH=',E14.7,
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0219      612 FORMAT(1H ,2X,'CIN=',6E14.7)
ISN 0220      610 CONTINUE
ISN 0221          RETURN
ISN 0222       50 CONTINUE
            C*****     TEST PRINT
            C
ISN 0223          IF(ITEST.EQ.0)GO TO 800
ISN 0225          WRITE(6,801)(CIN(IJP),IJP=1,6),PTHMX,PT,IBND
ISN 0226          WRITE(6,805)PATH,PTT,INCLD
ISN 0227      805 FORMAT(1H ,'PATH=',E14.7,2X,'PTT=',E14.7,2X,'INCLD=',I2)
ISN 0228      801 FORMAT(1H0,'CIN=',5(1X,E14.7,3X)/1H ,2X,'PTHMX=',E14.7,
                 *4X,'PT=',E14.7,4X,'IBND=',I2)
ISN 0229      800 CONTINUE
            C
            C*****
ISN 0230          IF(INCLD.EQ.0)GO TO 52
            C
            C     TEST TO SEE WHETHER WE WILL STILL BE IN THE CLOUD
            C
ISN 0232          DO 54 IJ=1,3
ISN 0233          CINT(IJ)=ABS(CIN(IJ)+PATH*CIN(IJ+3))
ISN 0234       54 IF(CINT(IJ).GT.CLOUD(INCLD,IJ+3))GO TO 55
            C
            C     PHOTON STAYS IN CLOUD, UPDATE
ISN 0236          GO TO 52
            C
            C     PHOTON EXITS CLOUD ALONG PATH
            C
ISN 0237       55 CALL CLOUT(INCLD,NOUT,CDIST,EXT)
ISN 0238          PATH=CDIST(INCLD)
ISN 0239          PT=PTT-PATH*TCLD
            C
            C     ADJUST PT FOR AMBIANT ATMOSPHERIC PASSAGE, GET NEW JJ
            C
ISN 0240          HT=EXT(INCLD,3)+CLOUD(INCLD,3)
ISN 0241          IF(CIN(6).GE.0.)GO TO 60
ISN 0243          JJP=JJ+1
ISN 0244          XHI=CIN(3)+CLOUD(INCLD,3)
ISN 0245          DO 62 IJ=1,JJ
ISN 0246          J=JJP-IJ
ISN 0247          XLOW=0.
ISN 0248          IF(J.NE.1)XLOW=XH(J-1)
```

PAGE 005

```
ISN 0250          IF(XLOW.LE.HT)GO TO 61
ISN 0252          PT=PT+(XHI-XLOW)*TOL(J)/CIN(6)
ISN 0253          XHI=XH(J)
ISN 0254       62 CONTINUE
ISN 0255       61 PT=PT+(XHI-HT)*TOL(J)/CIN(6)
ISN 0256          JJ=J
ISN 0257          GO TO 63
            C
            C     PHOTON RISING OR HORIZONTAL
            C
ISN 0258       60 IF(CIN(6).GT.0.)GO TO 64
ISN 0260          PT=PT-PATH*TOL(JJ)
ISN 0261          GO TO 63
ISN 0262       64 CONTINUE
ISN 0263          XLOW=CIN(3)+CLOUD(INCLD,3)
ISN 0264          DO 65 J=JJ,NLAYER
ISN 0265          IF(XH(J).GT.HT)GO TO 66
ISN 0267          PT=PT-(XH(J)-XLOW)*TOL(J)/CIN(6)
ISN 0268          LXOW=XH(J)
ISN 0269       65 CONTINUE
ISN 0270       66 PT=PT-(HT-XLOW)*TOL(J)/CIN(6)
ISN 0271          JJ=J
ISN 0272       63 CONTINUE
            C
            C     TRANSFORM TO GENERAL FRAME
            C
ISN 0273          DO 67 IJ=1,3
ISN 0274          IJ3=IJ+3
ISN 0275          CIN(IJ)=EXT(INCLD,IJ)
ISN 0276          CLCORD(IJ)=CIN(IJ)
ISN 0277       67 CLCORD(IJ3)=CIN(IJ3)
ISN 0278          INDC=+1
ISN 0279          CALL TRANS(INCLD,INDC)
ISN 0280          DO 68 IJ=1,6
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0281         88 CIN(IJ)=CCORD(IJ)
ISN 0282            CALL TRANS2(UN,VN,WN,UN,VN,WN,INCLD,INDC)
ISN 0283            INCLD=0
                 C
                 C------CONTINUE TRACKING
                 C
ISN 0284            GO TO 10
ISN 0285         52 CONTINUE
                 C
                 C     UPDATE CO-ORD VECTOR ALONG PATH
                 C
ISN 0286            DO 51 IJ=1,3
ISN 0287         51 CIN(IJ)=CIN(IJ)+PATH*CIN(IJ+3)
ISN 0288            JJ=J
ISN 0289            IF(ITEST.EQ.0)GO TO 806
ISN 0291            WRITE(6,807)INCLD,PATH,(CIN(IJP),IJP=1,6)
ISN 0292        807 FORMAT(1H ,'POSTRACK INCLD=',I2,4X,'PATH=',E14.7/1H ,'CIN=',6(2X,
                   .E14.7))
ISN 0293        806 CONTINUE
ISN 0294            RETURN
ISN 0295         99 CONTINUE
ISN 0296            WRITE(6,991)INCLD,J,JJ,(CIN(IJ),IJ=1,6),PT
ISN 0297        991 FORMAT(1H0,12C(1H*)/1H0,14HTRACKING ERROR/
                   .1H0,6HINCLD=,I2,2X,2HJ=,I3,2X,3HJJ=,I3/
                   .1H0,4HCIN=,6(E14.7,3X)/
                   .1H0,3HPT=,E14.7)
ISN 0298            WRITE(6,992)PTH,PTHMX,IEND,PTI
ISN 0299        992 FORMAT(1H ,'PTH=',E14.7,4X,'PTHMX=',E14.7,4X,'IEND=',I2/
                   .1H ,'PTI=',E14.7)
ISN 0300            ICUT=1
ISN 0301            RETURN
ISN 0302            END
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****   PAGE 006

```
SYMBOL  INTERNAL STATEMENT NUMBERS
I       0029 0030 0030 0055 0056 0056
J       0026 0055 0090 0091 0113 0123 0127 0152 0169 0181 0182 0183 0246 0248 0248 0252 0253 0255 0256
        0264 0265 0267 0267 0268 0270 0271 0288 0296
W       0072 0076 0096
AS      0024 0034 0037
CG      0006 0205 0206 0209 0210
DX      0007 0093 0162
HT      0066 0067 0240 0250 0255 0265 0270
IJ      0088 0089 0122 0123 0130 0131 0131 0134 0135 0135 0140 0141 0141 0144 0145 0145 0195 0196 0196
        0156 0201 0202 0202 0232 0233 0233 0233 0234 0234 0245 0246 0273 0274 0275 0275 0276 0275 0280
        0281 0281 0286 0287 0287 0287 0296 0296 0296
IX      0002 0013 0014
IY      0013 0014
JI      0120 0121 0121 0121
JJ      0026 0044 0044 0047 0074 0074 0077 0078 0083 0087 0127 0152 0155 0167 0168 0169 0177 0179 0197
        0216 0243 0245 0256 0260 0264 0271 0288 0296
JL      0160 0181
PT      0015 0016 0020 0023 0044 0047 0079 0085 0085 0092 0096 0096 0103 0109 0114 0114 0154 0155 0156
        0159 0170 0175 0175 0184 0168 0183 0216 0225 0239 0252 0252 0255 0255 0260 0260 0267 0267 0270
        0270 0296
UN      0006 0136 0136 0147 0147 0282 0282
VN      0006 0136 0136 0147 0147 0282 0282
WN      0006 0136 0136 0147 0147 0282 0282
XH      0007 0028 0061 0074 0124 0157 0243 0263 0265 0267 0268
XX      0013 0015
ADS     0233
ALB     0008
CIN     0006 0020 0030 0044 0044 0046 0046 0047 0047 0056 0064 0066 0067 0072 0076 0121 0121 0121 0124
        0131 0135 0141 0145 0150 0162 0162 0167 0167 0182 0193 0196 0196 0196 0202 0209 0210 0217 0225
        0233 0233 0241 0244 0252 0255 0258 0263 0267 0270 0275 0276 0277 0281 0287 0287 0287 0291 0296
DPT     0077 0079 0085 0091 0092 0096 0101 0103 0113 0114 0168 0170 0175 0183 0184 0188
ENT     0004 0037
EPS     0071 0081 0094 0172 0173 0196
EXT     0004 0237 0240 0275
IJP     0020 0020 0020 0225 0225 0225 0291 0291 0291
IJ3     0274 0277 0277
INC     0011
JJM     0087 0088 0089
JJP     0179 0180 0243 0246
PTH     0031 0034 0037 0063 0086 0094 0097 0097 0103 0112 0115 0153 0166 0176 0186 0189 0189 0216 0298
PTI     0016 0020 0216 0298
PTS     0154 0159
PTT     0023 0226 0239
```

```
TOR      0017  0044
XHI      0244  0252  0253  0255
XLO      0073  0074  0076
ACLD     0011
ALOG     0015
CINT     0083  0233  0234
DIST     0034  0237  0240
DPTH     0076  0077  0081  0086  0090  0091  0094  0097  0103  0112  0113  0115  0167  0168  0173  0176  0182  0183  0186
         0195  0216
EPSS     0012  0071  0172
IGND     0041  0051  0058  0069  0116  0118  0129  0164  0216  0225  0298
IENT     0037  0038  0040  0143  0146
INCC     0132  0133  0136  0142  0143  0147  0203  0204  0278  0279  0282
IOUT     0032  0213  0216  0300
IPRT     0217  0217  0217
LXCW     0266
NALB     0008
NOUT     0217
PATH     0046  0049  0103  0104  0104  0105  0115  0155  0157  0196  0216  0226  0233  0238  0239  0260  0287  0291
SCUT     0006
TCLD     0027  0054  0077  0091  0113  0155  0168  0183  0239
TGND     0067  0068  0069
TORT     0007  0044  0044  0047
TPHT     0026  0061  0162
TTOP     0162  0163  0164
XLOW     0247  0248  0250  0252  0263  0267  0270
AMINI    0068  0164  0163
CDIST    0034  0237  0238
CLOUD    0019  0057  0060  0061  0234  0240  0244  0263
CLOUT    0237
COORD    0010  0030  0135  0141  0205  0206  0281
GNDHT    0026  0060  0066  0076  0167
INCLD    0026  0020  0024  0054  0057  0060  0061  0133  0136  0137  0146  0147  0199  0204  0216  0226  0230  0234  0237
         0238  0240  0240  0244  0263  0275  0279  0282  0283  0291  0296
ISCAT    0032  0198
```

PAGE 007

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

```
SYMBOL   INTERNAL STATEMENT NUMBERS
ITEST    0015  0018  0214  0223  0289
NCLD1    0039
PTHMX    0040  0053  0057  0066  0068  0069  0071  0081  0094  0104  0105  0112  0121  0157  0163  0163  0164  0172  0173
         0166  0216  0225  0298
RANDU    0013
TDIST    0037
TRACK    0032
TRANS    0133  0143  0204  0279
CLCORD   0010  0036  0131  0145  0202  0276  0277
CLCNTR   0034
IENTER   0034  0034  0037
NCLOUD   0009  0032
NENTER   0034  0035  0037
NLAYER   0007  0028  0044  0061  0122  0124  0177  0180  0264
NPLANE   0037
TCLCLD   0011  0054
TRANS2   0136  0147  0282
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****   PAGE 008

```
LABEL   DEFINED   REFERENCES
  4     0149      0064
 10     0017      0136  0148  0284
 20     0053      0024
 21     0055
 22     0056      0055
 31     0030      0029
 32     0041      0032  0035  0038
 40     0062      0042  0052
 43     0098      0083
 44     0100      0079  0092  0170  0184
 45     0111      0081  0094  0107  0160  0173  0186
 46     0192      0047  0116
 47     0121      0120
 48     0129      0128
 49     0131      0130
```


ORIGINAL PAGE IS
OF POOR QUALITY

50	0222	0113 0118 0157
51	0287	0286
52	0285	0233 0236
54	0234	0232
55	0237	0234
60	0258	0241
61	0255	0250
62	0254	0245
63	0272	0257 0261
64	0262	0258
65	0269	0264
66	0270	0265
67	0277	0273
68	0281	0280
99	0295	0083 0099 0101 0177 0191
401	0161	0151
402	0192	0180
441	0108	0105
461	0212	0044 0193
462	0208	0199
463	0196	0195
464	0202	0201
471	0126	0122
472	0127	0124
488	0141	0140
489	0145	0144
499	0138	0134
800	0229	0223
801	0228	0220
803	0222	0018
804	0221	0020
805	0227	0225
806	0293	0289
807	0292	0291
810	0220	0214
811	0216	0210
812	0219	0217
991	0297	0296
992	0299	0298

ORIGINAL PAGE IS
OF POOR QUALITY

/ TRACK / SIZE OF PROGRAM 00140C HEXADECIMAL BYTES PAGE 009

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
I	SF	I*4	000300	J	SF	I*4	000304	W	SF	R*4	000308	AS	SFA	R*4	000380
CG	S C	R*4	0000CC	DX	F C	R*4	000644	FT	SF	R*4	0003CC	IJ	SFA	I*4	000310
IX	SFA	I*4	000314	IY	SFA	I*4	000318	JI	SF	I*4	00031C	JJ	SF C	I*4	000C24
JL	SF	I*4	000320	PT	SF	R*4	000324	UN	SFA C	R*4	000018	VN	SFA C	R*4	00001C
AN	SFA C	R*4	000020	XH	F C	R*4	000434	XX	SFA	R*4	000328	ALE	C	R*4	N.R.
CIN	SFA C	R*4	000000	DPT	SF	R*4	00032C	ENT	SFA	R*4	000308	EPS	S	R*4	000330
EAT	SFA	R*4	00045C	IJP	F	I*4	000334	IJ3	SF	I*4	000338	INC	C	I*4	N.R.
JJK	SF	I*4	00033C	JJP	SF	I*4	000340	PTH	SFA	R*4	000344	PTI	SF	R*4	000348
PTS	SF	R*4	00034C	PTT	SF	R*4	000350	TLL	F C	R*4	000324	TCR	C	R*4	000004
XHI	SF	R*4	000354	XLU	SF	R*4	000358	ACLD	C	R*4	N.R.	CINT	S	R*4	0004C8
DIST	SFA	R*4	0004EC	DPTH	SF	R*4	00035C	EPSS	SF	R*4	000360	IBND	SF	I*4	000364
IENT	SFA	I*4	000368	INDC	SFA	I*4	00036C	IOUT	SF	I*4	000370	IPRT	F	I*4	000374
LAUN	S	I*4	000378	NALU	C	I*4	N.R.	NOUT	SFA	I*4	00037C	PATH	SFA	R*4	000380
SCUT	C	R*4	N.R.	TCLU	SF	R*4	000384	TSND	SFA	R*4	000388	TCRT	C	R*4	000194
TPNT	SF	R*4	00038C	TTUP	SFA	R*4	000390	XLCW	SF	R*4	000394	CDIST	SFA	R*4	000508
CLOUD	F C	R*4	000008	CLOUT	SF XF	R*4	000000	CCORD	SF C	R*4	00000C	GNDHT	SF	R*4	000398
INCLD	SFA C	I*4	0000EE	ISCAT	S	I*4	00039C	ITEST	C	I*4	000000	NCLD1	C	I*4	N.R.
PIHMX	SFA	R*4	0003A0	RANDU	SF XF	R*4	000000	TDIST	SF XF	R*4	000000	TRACK		R*4	0003A4
TRANS	SF XF	R*4	000000	ALUG	XF	R*4	000000	CLCORD	SF C	R*4	000018	CLENTR	SF XF	R*4	000000
IJCCM#	F XF	I*4	000000	IENTER	SFA	I*4	000530	NCLOUD	C	I*4	000C00	NENTER	SFA	I*4	0003A8
NLAYER	F C	I*4	000000	NPLANE	SFA	I*4	0003AC	TCLCLD	F C	R*4	000028	TRANS2	SF XF	R*4	0000C0

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * TST* SIZE OF BLOCK 000004 HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
ITEST	I*4	000000									

NAME OF COMMON BLOCK * FHUT* SIZE OF BLOCK 00006C HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
CIN	R*4	000000	UN	R*4	000018	VN	R*4	00001C	WN	R*4	000020

```
     JJ       I*4    000C24             SOLT      R*4      N.R.           INCLD     I*4    000068

              NAME OF COMMON BLOCK   *    ATM*     SIZE OF BLOCK      0007C4 HEXADECIMAL BYTES

          VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.
           NLAYER      I*4    000000          TCR        R*4    000004          TURT       R*4    000194          TOL        R*4    000324
             XH        R*4    0004B4          EX         R*4    000644

              NAME OF COMMON BLOCK   *    GND*     SIZE OF BLOCK      0000C4 HEXADECIMAL BYTES

          VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.
            NALD       I*4    N.R.            ALD        R*4    N.R.             CG        R*4    0000CC

              NAME OF COMMON BLOCK   *  CLFAR*     SIZE OF BLOCK      000198 HEXADECIMAL BYTES

          VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.
           NCLCUD      I*4    000000         NCLD1       I*4    N.R.           CLOUD       R*4    000008

              NAME OF COMMON BLOCK   *CRENTE*     SIZE OF BLOCK      000030 HEXADECIMAL BYTES

          VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.
           CCCRD       R*4    000000         CLCCRD      R*4    000018

              NAME OF COMMON BLOCK   *CLDATM*     SIZE OF BLOCK      000078 HEXADECIMAL BYTES

          VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.     VAR. NAME   TYPE   REL. ADDR.
            INC        I*4    N.R.          TOLCLD       R*4    000028          ACLD       R*4    N.R.

      LABEL    ADDR                    LABEL    ADDR                    LABEL    ADDR                    LABEL    ADDR           PAGE 010

        10    00005E                    603    0000E5                     31    000722                    32    000794
        20    000336                     22    00085A                     21    000836 NR                 40    000EA8
        43    000A3E                     44    000A1E                    441    000A60                    45    000A6C
        47    000AC8                    471    000B1C                    472    000B24                    49    000B4A
       499    000B7C                     48    000BA6                    488    000BD2                   489    000BE4
         4    000C0E                    401    000C66                    402    000C58                    46    000DAA
       463    000D06                    464    000DFC                    462    000E46                   461    000E62
       810    000F0E                     50    000F1D                    800    000F98                    54    000FE8
        55    001002                     62    0010E0                     61    0010EC                    60    001120
        64    001148                     65    0011C4                     66    0011CE                    63    0011FC
        67    00123E                     68    001278                     52    0012A2                    51    001284
       806    001314                     59    00131C

 *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=32,SIZE=0000K,
 *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
 *STATISTICS*     SOURCE STATEMENTS =      301 ,PROGRAM SIZE =      5132
 *STATISTICS*  NO  DIAGNOSTICS GENERATED
 ****** END OF COMPILATION ******                                          125K BYTES OF CORE NOT USED

 LEVEL  21.6 (DEC 72)                          OS/360  FORTRAN H                                    DATE  76.324/21.46.44

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
    ISN 0002           SUBROUTINE TRANSI(I,INDC)
    ISN 0003           COMMON/CLFAR/NCLOUD,NCLD1,CLOUD(15,10)
    ISN 0004           COMMON/CRENTE/CCORD(6),CLCCRD(6)
    ISN 0005           IF(INDC)1,1,2
    ISN 0006         1 CLCCRD(1)=(CCORD(1)-CLOUD(I,1))*CLOUD(I,7)
                      .+(CCORD(2)-CLOUD(I,2))*CLOUD(I,8)
    ISN 0007           CLCCRD(2)=-(CCORD(1)-CLOUD(I,1))*CLOUD(I,8)
                      .+(CCORD(2)-CLOUD(I,2))*CLOUD(I,7)
    ISN 0008           CLCCRD(3)=CCORD(3)-CLOUD(I,3)
    ISN 0009           RETURN
    ISN 0010         2 CCORD(1)=CLOUD(I,1)+CLCCRD(1)*CLOUD(I,7)-CLCCRD(2)*CLOUD(I,8)
    ISN 0011           CCORD(2)=CLOUD(I,2)+CLCCRD(2)*CLOUD(I,7)+CLCCRD(1)*CLOUD(I,8)
    ISN 0012           CCORD(3)=CLCCRD(3)+CLOUD(I,3)
    ISN 0013           RETURN
    ISN 0014           END
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****                    PAGE 002
SYMBOL   INTERNAL STATEMENT NUMBERS
I        0002  0006  0006  0006  0006  0007  0007  0007  0007  0008  0010  0010  0010  0011  0011  0011  0012
INDC     0002  0008
CLOUD    0003  0006  0006  0006  0006  0007  0007  0007  0007  0008  0010  0010  0010  0011  0011  0011  0012
CLCRD    0004  0006  0006  0007  0007  0008  0010  0011  0012
NCLD1    0003
CLCORD   0004  0006  0007  0008  0010  0010  0011  0011  0012
NCLOUD   0003
TRANS1   0002

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****                    PAGE 003
LABEL   DEFINED   REFERENCES
  1     0006      0005  0005
  2     0010      0005

/ TRANS1 /   SIZE OF PROGRAM 000102 HEXADECIMAL BYTES   PAGE 004

   NAME  TAG  TYPE  ADD.      NAME   TAG  TYPE  ADD.      NAME   TAG  TYPE  ADD.      NAME   TAG  TYPE  ADD.
    I    F    I*4   000090    INDC        I*4   000094    CLOUD  F  C R*4   000008    CCORD SF  C  R*4  000000
   NCLD1   C  I*4   N.R.      CLCORD SF C R*4   000018    NCLOUD    C I*4   N.R.      TRANS1        R*4  000098

***** COMMON INFORMATION *****

   NAME OF COMMON BLOCK  *CLPAR*   SIZE OF BLOCK   000198 HEXADECIMAL BYTES
   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
   NCLOUD     I*4   N.R.         NCLD1      I*4   N.R.         CLOUD      R*4   000008

   NAME OF COMMON BLOCK  *ORDNIE*   SIZE OF BLOCK   000030 HEXADECIMAL BYTES
   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
   CCORD      R*4   000000       CLCORD     R*4   000018

   LABEL  ADDR            LABEL  ADDR            LABEL  ADDR            LABEL  ADDR                  PAGE 005
     1    0000CE            2    00013E

*OPTIONS IN EFFECT*   NAME= MAIN,OPT=02,LINECNT=82,SIZE=0000K,
*OPTIONS IN EFFECT*   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*   SOURCE STATEMENTS =      13 ,PROGRAM SIZE =      466
*STATISTICS*   NO DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                              181K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                 OS/360  FORTRAN H                          DATE  76.324/21.46.53
         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                            SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
  ISN 0002            SUBROUTINE TRANS2(X1,X2,X3,X,Y,Z,I,INDC)
                 C
                 C    TRANS2 CONVERTS DIRECTION COSINE VECTORS
                 C    INDC=-1  CONVERTS X,Y,Z TO CLOUD(I) COORDINATES
                 C         +1     CONVERTS X,Y,Z TO GENERAL FROM CLOUD(I) COORDINATES
                 C
  ISN 0003            COMMON/CLPAR/NCLOUD,NCLD1,CLOUD(10,10)
  ISN 0004            XX=X
  ISN 0005            YY=Y
  ISN 0006            ZZ=Z
  ISN 0007            FACT=+1.
  ISN 0008            IF(INDC.LT.0)FACT=-1.
  ISN 0010            C7=CLOUD(I,7)
  ISN 0011            C8=CLOUD(I,8)*FACT
  ISN 0012            X1=XX*C7-YY*C8
  ISN 0013            X2=XX*C8+YY*C7
  ISN 0014            X3=ZZ
  ISN 0015            RETURN
  ISN 0016            END
```

```
SYMBOL  INTERNAL STATEMENT NUMBERS
I       0002  0010  0011
X       0002  0004
Y       0002  0005
Z       0002  0005
C7      0010  0012  0013
C8      0011  0012  0013
XX      0004  0012  0013
X1      0002  0012
X2      0002  0013
X3      0002  0014
YY      0005  0012  0013
ZZ      0005  0014
FACT    0007  0008  0011
INDC    0002  0008
CLOUD   0003  0010  0011
NCLD1   0003
NCLOUD  0003
TRANS2  0002

                          /  TRANS2 /   SIZE OF PROGRAM 0001E0 HEXADECIMAL BYTES PAGE 003

   NAME   TAG  TYPE  ADD.      NAME   TAG  TYPE  ADD.      NAME   TAG  TYPE  ADD.      NAME   TAG  TYPE  ADD.
      I   F    I*4   00008C       X   F    R*4   000090       Y   F    R*4   000094       Z   F    R*4   000098
     C7   SF   R*4   00009C      C8   SF   R*4   0000A0      XX   SF   R*4   0000A4      X1   S    R*4   0000A8
     X2   S    R*4   0000AC      X3   S    R*4   0000B0      YY   SF   R*4   0000B4      ZZ   SF   R*4   0000B8
   FACT   SF   R*4   0000BC    INDC        I*4   0000C0   CLOUD   F  C R*4   0000C8   NCLD1     C  I*4   N.R.
 NCLOUD     C  I*4   N.R.    TRANS2        R*4   0000C4

                          *****  COMMON INFORMATION  *****

   NAME OF COMMON BLOCK  * CLPAR*   SIZE OF BLOCK   000198 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
      NCLOUD  I*4   N.R.            NCLD1   I*4   N.R.            CLOUD   R*4   000008

*OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*    SOURCE STATEMENTS =     15 ,PROGRAM SIZE =     480
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                                     181K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                    OS/360  FORTRAN H                         DATE  76.324/21.47.01

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
   ISN 0002           SUBROUTINE CLOUT(I,NOUT,CDIST,EXT)
   ISN 0003           DIMENSION C(3)
   ISN 0004           DIMENSION CDIST(10),EXT(10,3)
   ISN 0005           COMMON/CLPAR/NCLOUD,NCLD1,CLOUD(10,10)
   ISN 0006           COMMON/CRDNTE/COORD(6),CLCORD(6)
   ISN 0007           NOUT=0
   ISN 0008           CDIST(I)=0.
   ISN 0009           DO 6 K=1,3
   ISN 0010           IF(CLCORD(K+3))1,6,2
   ISN 0011         1 FACT=-1.
   ISN 0012           GO TO 3
   ISN 0013         2 FACT=+1.
   ISN 0014         3 CONTINUE
   ISN 0015           K2=MOD(K,3)+1
   ISN 0016           K3=MOD(K+1,3)+1
   ISN 0017           K4=K2+3
   ISN 0018           K5=K3+3
   ISN 0019           C(K)=FACT*CLOUD(I,3+K)
   ISN 0020           C(K2)=CLCORD(K2)+(C(K)-CLCORD(K))*CLCORD(K2+3)/CLCORD(K+3)
   ISN 0021           C(K3)=CLCORD(K3)+(C(K)-CLCORD(K))*CLCORD(K3+3)/CLCORD(K+3)
   ISN 0022           IF(ABS(C(K2)).LE.CLOUD(I,K4).AND.ABS(C(K3)).LE.CLOUD(I,K5))GO TO 7
   ISN 0024         6 CONTINUE
   ISN 0025           RETURN
   ISN 0026         7 EXT(I,1)=C(1)
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
      ISN 0027          EXT(I,2)=C(2)
      ISN 0028          EXT(I,3)=C(3)
      ISN 0029          CDIST(I)=(EXT(I,1)-CLCORD(1))**2+(EXT(I,2)-CLCORD(2))**2+
                       *(EXT(I,3)-CLCORD(3))**2
      ISN 0030          CDIST(I)=SQRT(CDIST(I))
      ISN 0031          NOUT=1
      ISN 0032          RETURN
      ISN 0033          END

                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****        PAGE 002

   SYMBOL   INTERNAL STATEMENT NUMBERS
   C        0003  0019  0020  0020  0021  0021  0022  0022  0026  0027  0028
   I        0002  0008  0019  0022  0022  0026  0027  0028  0029  0029  0029  0029  0030  0030
   K        0009  0010  0015  0016  0019  0019  0020  0020  0020  0021  0021  0021
   K2       0015  0017  0020  0020  0020  0022
   K3       0016  0018  0021  0021  0021  0022
   K4       0017  0022
   K5       0018  0022
   ABS      0022  0022
   EXT      0002  0004  0026  0027  0028  0029  0029  0029
   MOD      0015  0016
   FACT     0011  0013  0015
   NOUT     0002  0007  0031
   SQRT     0030
   CDIST    0002  0004  0008  0029  0030  0030
   CLCUD    0005  0019  0022  0022
   CLOUT    0002
   COORD    0006
   NCLD1    0003
   CLCORD   0006  0010  0020  0020  0020  0020  0021  0021  0021  0021  0029  0029  0029
   NCLOUD   0005

                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****        PAGE 003

     LABEL   DEFINED   REFERENCES
       1     0011      0010
       2     0013      0010
       3     0014      0012
       6     0024      0009  0010
       7     0026      0022

                                       /   CLOUT /    SIZE OF PROGRAM 000350 HEXADECIMAL BYTES PAGE 004

        NAME   TAG   TYPE  ADD.        NAME   TAG   TYPE  ADD.        NAME   TAG   TYPE  ADD.        NAME   TAG   TYPE  ADD.
          C SFA      R*4  0000B4          I  FA      I*4  000090          K SFA      I*4  000094         K2 SFA      I*4  000098
         K3 SFA      I*4  00009C         K4 S        I*4  0000A0         K5 S        I*4  0000A4        EXT SF   XR  R*4  000000
       FACT SF       R*4  0000A8       NOUT S        I*4  0000AC      CDIST SFA XR  R*4  000000      CLCUD F    C  R*4  000008
      CLOUT          R*4  0000B0      COORD      C  R*4  N.R.         NCLD1      C  I*4  N.R.          SQRT    XF   R*4  000000
     CLCORD  F    C  R*4  000018     NCLOUD      C  I*4  N.R.

                                    *****  COMMON INFORMATION  *****

            NAME OF COMMON BLOCK  * CLPAR*   SIZE OF BLOCK    000198 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
         NCLOUD   I*4   N.R.           NCLD1    I*4   N.R.           CLCUD    R*4   000008

            NAME OF COMMON BLOCK  *ORDNTE*   SIZE OF BLOCK    000030 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
         COORD    R*4   N.R.          CLCORD    R*4   000018

       LABEL   ADDR             LABEL   ADDR              LABEL   ADDR              LABEL   ADDR            PAGE 005
         1   00014C               2   000156                3   000160                6   00022C
         7   000254

   *OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,

   *OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

   *STATISTICS*    SOURCE STATEMENTS =     32 ,PROGRAM SIZE =     848
```


ORIGINAL PAGE IS
OF POOR QUALITY

```
*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                181K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                    OS/360  FORTRAN H                                DATE  76.324/21.47.09

               COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,
                                  SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
     ISN 0002               SUBROUTINE CLINP
     ISN 0003               DIMENSION THETAC(10),ZCL(10)
     ISN 0004               COMMON/CLPAR/NCLOUD,NCLDI,CLOUD(10,10)
     ISN 0005               COMMON/CLDATA/INC(10),TOCLD(10),ACLD(10)
     ISN 0006               COMMON/CHEAD/HC(10),AC(10),BC(10),CC(10),XCL(10),YCL(10),
                           .THDEG(10),CLDEN(10)
     ISN 0007               COMMON/CONST/PI,TPI
     ISN 0008               READ(5,1) NCLOUD
     ISN 0009               IF(NCLOUD.EQ.0)RETURN
     ISN 0011               READ(5,2)(HC(K),AC(K),BC(K),CC(K),XCL(K),YCL(K),THETAC(K),INC(K),
                           .CLDEN(K),K=1,NCLOUD)
                     C        NCLOUD=     NUMBER OF CLOUDS CONSIDERED
                     C      WHERE          XCL(K),YCL(K) ARE X AND Y COORDINATES OF THE CENTER
                     C                     OF MASS OF THE CLOUD
                     C                     HC(K)       = ALTITUDE OF LOWER SURFACE OF K TH CLOUD
                     C                                   IN KILOMETERS.
                     C                     AC(K),BC(K),CC(K) = DIMENTIONS OF THE K TH CLOUD IN
                     C                     THE X,Y, AND Z DIRECTIONS OF THE CLOUD COORDINATE
                     C                     SYSTEM.
                     C                     THETAC(K)   = ANGLE BETWEEN THE X AXIS OF THE CLOUD AND
                     C                                   THAT OF THE GENERAL COORDINATE SYSTEM
                     C                                   (MEASURED CLOCKWISE IN DEGREES LOOKING UP
                     C                                   FROM THE GROUND)
                     C                     INC(K)      = INDICATION OF THE ATMOSPHERIC
                     C                                   CONSTITUENT APPROPRIATE TO THIS CLOUD.
     ISN 0012             1 FORMAT(I3)
     ISN 0013             2 FORMAT(F8.5,5F8.3,F8.5,I3,E9.3)
     ISN 0014               PI=3.14159
     ISN 0015               RADCON=PI/180.
     ISN 0016               DO 5 I=1,NCLOUD
     ISN 0017               THDEG(I)=THETAC(I)
     ISN 0018               THETAC(I)=THETAC(I)*RADCON
     ISN 0019             5 CONTINUE
     ISN 0020               DO 3 I=1,NCLOUD
     ISN 0021               DO 3 J=1,10
     ISN 0022             3 CLOUD(I,J)=0.
                     C      FORMING CLOUD (I,J) ARRAY
     ISN 0023               DO 4 I=1,NCLOUD
     ISN 0024               CLOUD(I,4)=AC(I)*0.5
     ISN 0025               CLOUD(I,5)=BC(I)*0.5
     ISN 0026               CLOUD(I,6)=CC(I)*0.5
     ISN 0027               CLOUD(I,1)=XCL(I)
     ISN 0028               CLOUD(I,2)=YCL(I)
     ISN 0029               CLOUD(I,3)=HC(I)+CLOUD(I,6)
     ISN 0030               ZCL(I)=CLOUD(I,3)
     ISN 0031               CLOUD(I,7)= COS (THETAC(I))
     ISN 0032               CLOUD(I,8)= SIN (THETAC(I))
     ISN 0033               CLOUD(I,10)=CLOUD(I,4)*CLOUD(I,4)+CLOUD(I,5)*CLOUD(I,5)+CLOUD(I,6)
                           .*CLOUD(I,6)
     ISN 0034             4 CLOUD(I,9)=SQRT(CLOUD(I,10))
                     C      CLOUD(I,J)          10 SPECIFICATION PARAMETERS FOR EACH OF UP TO
                     C                          10 CLOUDS
                     C      I                   CLOUD POINTER
                     C      J=1,2,3             XMC,YMC,ZMC COORDINATES OF CENTER OF MASS OF
                     C                          THE  CLOUD
                     C      J=4,5,6             A,B,C  THE HALF-DIMENSIONS OF EACH SIDE OF THE
                     C                          CLOUD
                     C      J=7,8               COS(THETAC),SIN(THETAC) WHERE THETAC IS THE
                     C                          ORIENTATION OF THE CLOUD
                     C      J=9                 R  RADIUS OF THE CIRCUMSCRIBING SPHERE AROUND
                     C                          THE CLOUD
                     C      J=10                R**2  SQUARE OF THE RADIUS(PARAMETER J=9)
                     C      COORD(6)            SIX VECTOR POSITION OF THE PHOTON AT LAST
                     C                          SCATTERING IN GENERAL SPACE
                     C      CLCORD(6)           SIX VECTOR POSITION OF THE PHOTON AT LAST
                     C                          SCATTERING IN CLOUD SYSTEM UNDER CONSIDERATION
                     C      CNEW(6)             SIX VECTOR POSITION OF NEW SCATTERING POINT
                     C                          IN THE LAST SYSTEM (CLOUD OR GENERAL)
                     C      ICORD               COORDINATE SYSTEM INDICATOR
                     C                          0   GENERAL SYSTEM
                     C                          1 THRU 10 CLOUD SYSTEM
                     C      CORR(I,J)           X-XC,Y-YC,Z-ZC COMPUTED FOR I TH CLOUD
```

```
          C                  WHEN IN GENERAL COORDINATE SYSTEM
          C       J=1        X-XC
          C       J=2        Y-YC
          C       J=3        Z-ZC
  ISN 0035        RETURN
  ISN 0036        END
```



```
                 *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

SYMBOL  INTERNAL-STATEMENT-NUMBERS
I       0016 0017 0017 0018 0018 0020 0022 0023 0024 0024 0025 0025 0026 0026 0027 0027 0028 0028 0029
        0029 0029 0030 0030 0031 0031 0032 0032 0033 0033 0033 0033 0033 0033 0033 0034 0034
J       0021 0022
K       0011 0011 0011 0011 0011 0011 0011 0011 0011 0011 0011
AC      0006 0011 0024
BC      0006 0011 0025
CC      0006 0011 0026
HC      0006 0011 0029
PI      0007 0014 0015
COS     0031
INC     0005 0011
SIN     0032
TPI     0007
XCL     0006 0011 0027
YCL     0006 0011 0028
ZCL     0006 0030
ACLD    0005
SORT    0034
CLDEN   0006 0011
CLINP   0012
CLOUD   0004 0022 0024 0025 0026 0027 0028 0029 0029 0030 0031 0032 0033 0033 0033 0033 0033 0033 0033
        0034 0034
NCLD1   0004
THDEG   0006 0017
NCLOUD  0004 0008 0009 0011 0016 0020 0023
RADCON  0015 0018
THETAC  0003 0011 0017 0018 0018 0031 0032
TOLCLD  0005
```



```
                 *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

  LABEL   DEFINED   REFERENCES
    1     0012      0008
    2     0013      0011
    3     0022      0020  0021
    4     0034      0023
    5     0019      0016

                              /  CLINP  /    SIZE OF PROGRAM 0003AE HEXADECIMAL BYTES PAGE 004

     NAME  TAG   TYPE  ADD.        NAME  TAG   TYPE  ADD.        NAME  TAG   TYPE  ADD.        NAME  TAG   TYPE  ADD.
        I  SFA   I*4   0000D4         J  SF    I*4   0000D8         K  F     I*4   0000DC        AC  SF  C R*4   000028
       BC  SF  C R*4   000050        CC  SF  C R*4   000078        HC  SF  C R*4   0000C0        PI  SF  C R*4   000000
      INC  S   C I*4   000000       TPI      C R*4   N.R.         XCL  SF  C R*4   0000A0       YCL  SF  C R*4   0000C8
      ZCL  S   C R*4   0000E8      ACLD      C R*4   N.R.       CLDEN  S   C R*4   000118     CLINP        R*4   0000E0
    CLOUD  SFA C R*4   000008     NCLD1      C I*4   N.R.       THDEG  S   C R*4   0000F0      SORT    XF   R*4   000000
      SIN    XF  R*4   000000       COS    XF  R*4   000000     IBCOM#   F  XF R*4   000000    NCLOUD  SF  C I*4   000000
   RADCON  SF    R*4   0000E4    THETAC  SFA   R*4   000110    TOLCLD      C R*4   N.R.

                                  *****  COMMON INFORMATION  *****

         NAME OF COMMON BLOCK  * CLPAR*     SIZE OF BLOCK     000198 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
    NCLOUD    I*4    000000       NCLD1     I*4    N.R.         CLOUD     R*4    000008

         NAME OF COMMON BLOCK  *CLDATM*     SIZE OF BLOCK     000078 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
      INC     I*4    00000C       TOLCLD    R*4    N.R.          ACLD     R*4    N.R.

         NAME OF COMMON BLOCK  * CREAD*     SIZE OF BLOCK     000140 HEXADECIMAL BYTES
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
   VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.
        HC      R*4    000000             AC     R*4    000028             EC     R*4    000050             CC     R*4    000078
        XCL     R*4    0000A0            YCL     R*4    0000C8          THDEG     R*4    0000F0          CLDEN     R*4    000118

         NAME OF COMMON BLOCK  * CONST*   SIZE OF BLOCK    000008 HEXADECIMAL BYTES

   VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.    VAR. NAME   TYPE   REL. ADDR.
        PI      R*4    000000            TPI     R*4      N.R.

        LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR           PAGE 005

          5  00027C                  3  0002A4                  4  000364

  *OPTIONS IN EFFECT*       NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,

  *OPTIONS IN EFFECT*       SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,IC,XREF

  *STATISTICS*      SOURCE STATEMENTS =       35 ,PROGRAM SIZE =        942

  *STATISTICS*  NO  DIAGNOSTICS GENERATED

  ****** END OF COMPILATION ******                                      173K BYTES OF CORE NOT USED

  LEVEL  21.6  (JEC 72)                          OS/360  FORTRAN H                        DATE  76.324/21.47.17

            COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,
                               SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,IC,XREF
     ISN 0002                SUBROUTINE CLENTR(PATH,AS,IENTER,NENTER)
                      C      SUBROUTINE CLENTR
                      C      THIS SUBROUTINE CHECKS WHETHER A PHOTON ENTERED THE CLOUD AND
                      C      CALCULATES THE POSITION OF THE PHOTON IN THE CLOUD COORDINATE
                      C      SYSTEM WHICH READILY CAN BE CONVERTED INTO THE GENERAL COORDINATE
                      C      SYSTEM
     ISN 0003                DIMENSION AS(10),IENTER(10)
     ISN 0004                COMMON/CLEAR/NCLOUD,NCLD1,CLOUD(10,10)
     ISN 0005                COMMON/CRUNTE/COORD(6),CLCORD(6)
     ISN 0006                COMMON/PHOT/CIN(6),UN,VN,WN,JJ,SCUT(16),INCLD
                      C      FIRST STEP IS TO FIND WHETHER THE PATH CAN ENTER ANY SPHERE
                      C      CIRCUMSCRIBING THE CLOUD.
     ISN 0007                NENTER=0
     ISN 0008                IF(NCLOUD.LE.0)GO TO 99
     ISN 0010                DO 6 I=1,NCLOUD
     ISN 0011                IF(I.EQ.INCLD)GO TO 6
     ISN 0013                DCM   =(CLOUD(I,1)-COORD(1))**2+(CLOUD(I,2)-COORD(2))**2+(CLOUD(I,
                            .3)-COORD(3))**2
     ISN 0014                PCL   =(CLOUD(I,1)-COORD(1))*COORD(4)+(CLOUD(I,2)-COORD(2))*COORD(
                            .5)+(CLOUD(I,3)-COORD(3))*COORD(6)
                      C      DCM    = THE SQUARE OF THE DISTANCE FROM THE CENTER OF MASS OF THE
                      C      CLOUD (XCL,YCL,ZCL) TO THE PHOTON PREVIOUS POSITION(XP,YP,ZP)
                      C      PCL      = THE LENGTH BETWEEN THE POINT OF CLOSEST APPROACH
                      C      FROM THE I TH CLOUD AND PHOTON PREVIOUS POSITION
     ISN 0015                PC=DCM-(PCL)**2
                      C      SQRT(PC    = PERPENDICULAR DISTANCE FROM THE CENTER OF I TH CLOUD
                      C      TO THE POINT OF CLOSEST APPROACH.
     ISN 0016                IF(PCL    .LT.0.) GO TO 6
     ISN 0018                IF(PC     -CLOUD(I,10))8,8,6
     ISN 0019          8     PS=CLOUD(I,10)-PC
     ISN 0020                AS(I)=PCL-SQRT(PS)
                      C      AS(I)= THE DISTANCE OF THE PHOTON PREVIOUS POSITION TO THE SPHERE
     ISN 0021                IF(PATH.LE.AS(I)) GO TO 6
                      C      FINDING OUT ABOUT THE POSSIBLE CLOUDS PHOTONS CAN ENTER.
     ISN 0023                NENTER=NENTER+1
     ISN 0024                IENTER(NENTER)=I
     ISN 0025                IF(I.EQ.1)GO TO 6
     ISN 0027                DO 7 J=1,NENTER
                      C      ARRANGING THE CLOUDS IN SEQUENCE ACCORDING TO PHOTON ENTRY.
     ISN 0028                IF(AS(I).LT.AS(IENTER(J))) GO TO 9
     ISN 0030          7     CONTINUE
     ISN 0031                GO TO 6
     ISN 0032          9     CONTINUE
     ISN 0033                NNN=J+1
     ISN 0034                DO 10 K=NNN,NENTER
     ISN 0035                KK=NENTER-K+NNN
     ISN 0036         10     IENTER(KK)=IENTER(KK-1)
     ISN 0037                IENTER(J)=I
     ISN 0038          6     CONTINUE
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0039          99 CONTINUE
ISN 0040             RETURN
ISN 0041             END

                     *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002

SYMBOL   INTERNAL STATEMENT NUMBERS
I        0010  0011  0013  0013  0013  0014  0014  0014  0018  0019  0020  0021  0024  0025  0028  0037
J        0027  0028  0033  0037
K        0034  0035
AS       0032  0003  0020  0021  0028  0028
JJ       0036
KK       0035  0036  0036
PC       0015  0018  0019
PS       0015  0020
UN       0006
VN       0006
WN       0006
CIN      0006
JCM      0013  0016
NNM      0033  0034  0035
PCL      0014  0015  0016  0020
PATH     0022  0021
SCUT     0006
SORT     0020
CLOUD    0004  0013  0013  0013  0014  0014  0014  0018  0019
COORD    0005  0013  0013  0013  0014  0014  0014  0014  0014  0014
INCLD    0006  0011
NCLD1    0004
CLCORD   0005
CLENTR   0032
IENTER   0032  0003  0024  0028  0036  0036  0037
NCLOUD   0004  0008  0010
NENTER   0002  0007  0023  0023  0024  0027  0034  0035

                     *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003

LABEL   DEFINED   REFERENCES
  6      0038     0010  0011  0016  0018  0018  0021  0025  0031
  7      0030     0027
  8      0019     0018
  9      0032     0028
 10      0036     0034
 99      0039     0038

                                   /  CLENTR  /     SIZE OF PROGRAM 0003AE HEXADECIMAL BYTES PAGE 004

  NAME    TAG   TYPE  ADD.        NAME   TAG   TYPE  ADD.        NAME   TAG   TYPE  ADD.        NAME   TAG   TYPE  ADD.
     I  SF      I*4   00009C         J  SF     I*4   0000A0         K  SF     I*4   0000A4        AS  S   XR  R*4   000000
    JJ     C    I*4   N.R.          KK  SF     I*4   0000A8        PC  SF     R*4   0000AC        PS  SFA     R*4   000080
    UN     C    R*4   N.R.          VN     C   R*4   N.R.          WN     C   R*4   N.R.         CIN     C    R*4   N.R.
   JCM  SF      R*4   000084       NNM  SF     I*4   0000B8       PCL  SF     R*4   0000BC      PATH          R*4   0000C0
  SCUT     C    R*4   N.R.       CLOUD  F  C   R*4   000008     COORD  F  C   R*4   000000     INCLD     C    I*4   000068
 NCLD1     C    I*4   N.R.        SORT     XF  R*4   000000    CLCORD     C   R*4   N.R.      CLENTR          R*4   0000C4
IENTER  SF  XR  I*4   000000    NCLOUD  F  C   I*4   000000    NENTER  SF     I*4   0000C8

                               *****  COMMON  INFORMATION  *****

      NAME OF COMMON BLOCK  * CLPAR*   SIZE OF BLOCK    000198 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
    NCLOUD    I*4    000000        NCLD1    I*4    N.R.          CLOUD    R*4    000008

      NAME OF COMMON BLOCK  *ORENTE*   SIZE OF BLOCK    000030 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
    COORD     R*4    000000       CLCORD    R*4    N.R.

      NAME OF COMMON BLOCK  *  PHOT*   SIZE OF BLOCK    00006C HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
      CIN     R*4    N.R.           UN      R*4    N.R.            VN     R*4    N.R.            WN     R*4    N.R.
      JJ      I*4    N.R.          SCUT     R*4    N.R.          INCLD    I*4    000068
```

ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS OF POOR QUALITY

```
LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              PAGE 005
    8   000228                7   0002C4                9   0002CA               10   0002F8
    6   000324               99   00033A

*OPTIONS IN EFFECT*    NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

*OPTIONS IN EFFECT*    SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

*STATISTICS*    SOURCE STATEMENTS =      40 ,PROGRAM SIZE =       942

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                    173K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                         OS/360  FORTRAN H                         DATE  76.324/21.47.25

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
      ISN 0002             SUBROUTINE SDIST(NENTER,IENTER,JENTER,ENT,DIST,NPLANE)
                     C     TREATMENT IN THE UNELIMINATED CLOUD
                     C     TEST FROM WHICH PLANE OF THE CLOUD PHOTON ENTERED AND CALCULATE
                     C     APPROPRIATE POSITION (X,Y,Z) OF THE PHOTON IN THAT (ICORD=I)
                     C     CLOUD COORDINATE SYSTEM
                     C     SUBROUTINE SDIST CALCULATES DISTANCES TO ALL THE POSSIBLE
                     C     CLOUDS THE PHOTON ENTERS.
      ISN 0003             DIMENSION IENTER(10),JENTER(10),ENT(10,3), DIST(10)
      ISN 0004             INDC=-1
      ISN 0005             NENT=0
      ISN 0006             IF(NENTER.LE.0)GO TO 1
      ISN 0008             DO 1 J=1,NENTER
      ISN 0009             I=IENTER(J)
      ISN 0010             CALL PLANE (I,INDC   ,ENT,NPLANE,DIST)
      ISN 0011             IF(NPLANE.LE.0) GO TO 1
      ISN 0013             NENT=NENT+1
      ISN 0014             JENTER(NENT)=I
      ISN 0015             IF(I.EQ.1)GO TO 1
      ISN 0017             DO 8 K=1,NENT
      ISN 0018             IF(DIST(I).LT.DIST(JENTER(K)))GO TO 9
      ISN 0020           8 CONTINUE
      ISN 0021             GO TO 1
      ISN 0022           9 NNM=K+1
      ISN 0023             DO 10 JK=NNM,NENT
      ISN 0024             JKK=NENT-JK+NNM
      ISN 0025          10 JENTER(JKK)=JENTER(JKK-1)
      ISN 0026             JENTER(K)=I
      ISN 0027           1 CONTINUE
      ISN 0028             NENTER=NENT
      ISN 0029             RETURN
      ISN 0030             END

                   *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002

SYMBOL    INTERNAL STATEMENT NUMBERS
  I       0009  0010  0014  0015  0018  0026
  J       0008  0009
  K       0017  0018  0022  0026
  JK      0023  0024
  ENT     0002  0003  0010
  JKK     0024  0025  0025
  NNM     0022  0023  0024
  DIST    0002  0003  0010  0018  0018
  INDC    0004  0010
  NENT    0005  0013  0013  0014  0017  0023  0024  0028
  PLANE   0010
  SDIST   0002
  IENTER  0002  0003  0009
  JENTER  0002  0003  0014  0018  0025  0025  0026
  NENTER  0002  0006  0008  0028
  NPLANE  0002  0010  0011

                   *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003

LABEL   DEFINED   REFERENCES
  1      0027     0006  0008  0011  0015  0021
  8      0020     0017
  9      0022     0018
 10      0025     0023
```

```
                                   /   SDIST /     SIZE OF PROGRAM 0002C8 HEXADECIMAL BYTES PAGE 004

      NAME  TAG    TYPE  ADD.        NAME   TAG   TYPE  ADD.       NAME    TAG   TYPE  ADD.       NAME   TAG    TYPE  ADD.
         I  SFA    I*4   000094         J  SF     I*4   000098        K  SF      I*4   00009C       JK  SF      I*4   0000A0
       ENT  SFA XR R*4   000000       JKK  SF     I*4   0000A4      KKM  SF      I*4   0000A8     DIST  SFA XR  R*4   000000
      INDC  SFA    I*4   0000AC      NENT  SF     I*4   0000B0    PLANE  SF   XF R*4   000000    SDIST          R*4   0000B4
    IENTER  F   XR I*4   000000    JENTER  SF  XR I*4   000000   NENTER  SF      I*4   0000B8   NPLANE  SFA     I*4   0000BC

    LABEL  ADDR               LABEL  ADDR               LABEL  ADDR               LABEL  ADDR          PAGE 005

        6  0001D0                 9  0001EE                10  0001D4                 1  0001FC

 *OPTIONS IN EFFECT*    NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

 *OPTIONS IN EFFECT*    SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

 *STATISTICS*    SOURCE STATEMENTS =      24, PROGRAM SIZE =      718

 *STATISTICS*  NO DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                                      181K BYTES OF CORE NOT USED

 LEVEL  21.6  (DEC 72)                     OS/360  FORTRAN H                              DATE  76.324/21.47.34

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
    ISN 0002              SUBROUTINE PLANE(I,INDC  ,ENT,NPLANE,DIST)
                    C     SUBROUTINE PLANE CALCULATES THE POINT  OF ENTRY OF THE PHOTON
                    C     THROUGH A PLANE OF THE CLOUD AND DETERMINES THE DISTANCE
                    C     TO THE POINT OF ENTRY (ENT(I,J)) FROM THE LAST POSITION
                    C     OF THE PHOTON.
    ISN 0003              DIMENSION C(3),ENT(10,3),DIST(10)
    ISN 0004              COMMON/CLEAR/NCLOUD,NCLD1,CLOUD(10,10)
    ISN 0005              COMMON/CRENTE/COORD(6),CLCCRD(6)
    ISN 0006              NPLANE=0
    ISN 0007              CALL TRANS(I,INDC)
    ISN 0008              DO 6 K=1,3
    ISN 0009              IF(ABS(CLCORD(K)).LE.CLOUD(I,3+K)) GO TO 6
    ISN 0011              IF(CLCCRD(K).LT.CLOUD(I,3+K))FACT=-1
    ISN 0013              IF(CLCCRD(K).GT.CLOUD(I,3+K))FACT=1.
    ISN 0015              C(K)=FACT*CLOUD(I,3+K)
    ISN 0016              Q=C(K)
    ISN 0017              IF((CLCCRD(K)-Q)*CLCCRD(3+K).GT.0.) GO TO 6
    ISN 0019              IF(CLCCRD(3+K).EQ.0.)GO TO 6
    ISN 0021              K2=MOD(K,3)+1
    ISN 0022              C(K2)=CLCCRD(K2)+(CLCCRD(K2+3)/CLCCRD(K+3))*(C(K)-CLCORD(K))
    ISN 0023              K3=MOD(K+1,3)+1
    ISN 0024              C(K3)=CLCCRD(K3)+(CLCCRD(K3+3)/CLCCRD(K+3))*(C(K)-CLCCRD(K))
    ISN 0025              K4=K2+3
    ISN 0026              K5=K3+3
    ISN 0027              IF(ABS(C(K2)).LE.CLOUD (I,K4).AND.ABS(C(K3)).LE.CLOUD (I,K5)) GO
                         1TO 7
    ISN 0029        6     CONTINUE
    ISN 0030              RETURN
    ISN 0031        7     NPLANE=1
    ISN 0032              ENT(I,1)=C(1)
    ISN 0033              ENT(I,2)=C(2)
    ISN 0034              ENT(I,3)=C(3)
    ISN 0035              DIST(I)=(ENT(I,1)-CLCCRD(1))**2+(ENT(I,2) -CLCCRD(2))**2+(ENT(I,3)
                         *-CLCORD(3))**2
    ISN 0036              DIST(I)=SQRT(DIST(I))
    ISN 0037              RETURN
    ISN 0038              END

                      *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002

 SYMBOL   INTERNAL STATEMENT NUMBERS
 C        0003  0015  0016  0022  0022  0024  0024  0027  0027  0032  0033  0034
 I        0002  0007  0009  0011  0013  0015  0027  0027  0032  0033  0034  0035  0035  0035  0035  0036  0036
 K        0008  0009  0009  0011  0011  0013  0013  0015  0015  0016  0017  0017  0019  0021  0022  0022  0022  0023  0024
          0024  0024
 Q        0016  0017
 K2       0021  0022  0022  0022  0025  0027
 K3       0023  0024  0024  0024  0026  0027
 K4       0025  0027
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
K5        C026  0027
ABS       CCC5  0027  CC27
ENT       C002  CCC3  CC32  0033  0034  0035  0035  0035
MOD       C021  0023
DIST      C002  CCC3  0035  0036  0036
FACT      C011  0013  C015
INDC      C002  0007
SQRT      C016
CLOUD     C004  0009  C011  C013  C015  C027  C027
COORD     C005
NCLD1     C004
PLANE     C002
TRANS     C007
CLCORD    C005  0009  0011  0013  0017  C017  C019  0022  0022  0022  0022  C024  0024  C024  0024  0035  0035  0035
NCLCUD    C004
NPLANE    CC02  CCC6  CC31

            *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****            PAGE 003

  LABEL   DEFINED   REFERENCES
    6      C025     CCC8  C005  C017  C019
    7      C031     CC27

                              /    PLANE /     SIZE OF PROGRAM C00412 HEXADECIMAL BYTES PAGE 004

    NAME   TAG   TYPE  ADD.        NAME  TAG   TYPE  ADD.        NAME  TAG   TYPE  ADD.       NAME  TAG   TYPE  ADD.
       C SFA     R*4   0000D4         I SFA     I*4   0000A8         K SFA     I*4   0000AC         Q S       R*4   0000B0
      K2 SFA     I*4   0000E4        K3 SFA     I*4   0000B8        K4 S       I*4   0000BC        K5 S       I*4   0000C0
     ENT SF  XR  R*4   000000      DIST SFA XR  R*4   000000      FACT SF      R*4   0000C4      INDC SFA     I*4   0000C8
   CLOUD F   C   R*4   000008     COORD      C  R*4   N.R.        NCLD1     C  I*4   N.R.       PLANE        R*4   0000CC
   TRANS SF  XF  R*4   000000      SQRT     XF  R*4   000000     CLCORD FA  C  R*4   000018    NCLCUD     C  I*4   N.R.
  NPLANE S       I*4   0000D0

                              *****   COMMON INFORMATION   *****

        NAME OF COMMON BLOCK  * CLPAR*    SIZE OF BLOCK     000198 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
    NCLCUD    I*4    N.R.         NCLD1     I*4    N.R.         CLOUD     R*4   C00008

        NAME OF COMMON BLOCK  *CRONTE*    SIZE OF BLOCK     000030 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
    COORD     R*4    N.R.         CLCORD    R*4   000018

     LABEL   ADDR                  LABEL   ADDR                  LABEL   ADDR                  LABEL   ADDR        PAGE 005
       6   0002C2                    7   0002EE

 *OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

 *OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

 *STATISTICS*     SOURCE STATEMENTS =      37 ,PROGRAM SIZE =     1042

 *STATISTICS*  NO  DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                                   173K BYTES OF CORE NOT USED

 LEVEL  21.6  (DEC 72)                     OS/360  FORTRAN H                          DATE  76.324/21.47.47

         COMPILER OPTIONS -- NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
    ISN 0002           SUBROUTINE TRANS (ICORD,INDC)
    ISN 0003           COMMON/CLPAR/NCLCUD,NCLD1,CLOUD(10,10)
    ISN 0004           COMMON/CRONTE/COORD(6),CLCORD(6)
    ISN 0005           I=ICORD
                 C       IF INDC= POSITIVE  CONVERTION TO CLOUD COORDINATE
                 C       COORDINATE SYSTEM TO GENERAL SYSTEM TAKES PLACE.
                 C       IF INDC= NEGATIVE  CONVERTION TO CLOUD COORDINATE
                 C       SYSTEM FROM GENERAL GENERAL COORDINATE SYSTEM TAKES PLACE.
    ISN 0006           IF(INDC)1,1,2
    ISN 0007         1 CLCORD(1)=(COORD(1)-CLOUD(I,1))*CLOUD(I,7)+(COORD(2)-CLOUD(I,2))*C
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                         .LOUD(I,8)
ISN 0008                  CLCCRD(2)=-(COORD(1)-CLOUD(I,1))*CLOUD(I,8)+(COORD(2)-CLOUD(I,2))*
                         .CLOUD(I,7)
ISN 0009                  CLCCRD(3)=COORD(3)-CLOUD(I,3)
ISN 0010                  CLCCRD(4)=CLCCRD(4)*CLOUD(I,7)+CCCRD(5)*CLOUD(I,8)
ISN 0011                  CLCCRD(5)=-CLCRD(4)*CLOUD(I,8)+CCCRD(5)*CLOUD(I,7)
ISN 0012                  CLCCRD(6)=COORD(6)
ISN 0013                  GO TO 4
ISN 0014          2       COORD(1)=CLOUD(I,1)+CLCCRD(1)*CLOUD(I,7)-CLCCRD(2)*CLOUD(I,8)
ISN 0015                  COORD(2)=CLOUD(I,2)+CLCCRD(2)*CLOUD(I,7)+CLCCRD(1)*CLOUD(I,8)
ISN 0016                  COORD(3)=CLCCRD(3)+CLOUD(I,3)
ISN 0017                  COORD(4)=CLCCRD(4)*CLOUD(I,7)-CLCCRD(5)*CLOUD(I,8)
ISN 0018                  COORD(5)=CLCCRD(4)*CLOUD(I,8)+CLCCRD(5)*CLOUD(I,7)
ISN 0019                  COORD(6)=CLCCRD(6)
ISN 0020          4       RETURN
ISN 0021                  END

                 *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002

SYMBOL    INTERNAL STATEMENT NUMBERS
 I        0005  0007  0007  0007  0007  0008  0008  0008  0008  0009  0010  0010  0011  0011  0014  0014  0014  0015  0015
          0015  0016  0017  0017  0018  0018
 INDC     0002  0006
 CLOUD    0003  0007  0007  0007  0007  0008  0008  0008  0008  0009  0010  0010  0011  0011  0014  0014  0014  0015  0015
          0015  0016  0017  0017  0018  0018
 CLCRD    0004  0007  0007  0008  0008  0009  0010  0010  0011  0011  0012  0014  0015  0016  0017  0018  0019
 ICORD    0002  0005
 NCLD1    0003
 TRANS    0002
 CLCORD   0004  0007  0008  0009  0010  0011  0012  0014  0014  0015  0015  0016  0017  0017  0018  0018  0019
 NCLOUD   0003

                 *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003

 LABEL    DEFINED    REFERENCES
   1      0007       0006  0006
   2      0014       0006
   4      0020       0013

                                   /  TRANS /    SIZE OF PROGRAM 00025E HEXADECIMAL BYTES PAGE 004

     NAME    TAG   TYPE  ADD.        NAME   TAG   TYPE  ADD.       NAME   TAG   TYPE  ADD.       NAME   TAG   TYPE  ADD.
        I SF       I*4   0000SC      INDC         I*4   0000A0     CLOUD  F   C  R*4   0000C8     COORD  SF   C  R*4   000000
    ICORD  F       I*4   0000A4      NCLD1      C I*4   N.R.       TRANS         R*4   0000A8     CLCORD SF   C  R*4   000018
    NCLOUD      C  I*4   N.R.

                             *****  COMMON INFORMATION  *****

     NAME OF COMMON BLOCK  * CLPAR*   SIZE OF BLOCK    000198 HEXADECIMAL BYTES

    VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
     NCLOUD     I*4     N.R.       NCLD1      I*4     N.R.       CLOUD      R*4   000008

     NAME OF COMMON BLOCK  *ORDNTE*   SIZE OF BLOCK    000030 HEXADECIMAL BYTES

    VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
     COORD      R*4   000000       CLCORD     R*4   000018

   LABEL   ADDR               LABEL   ADDR               LABEL   ADDR               LABEL   ADDR          PAGE 005

     1   0000E8                 2   0001EE                 4   000226

 *OPTIONS IN EFFECT*    NAME= MAIN,OPT=02,LINECNT=82,SIZE=0000K,

 *OPTIONS IN EFFECT*    SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

 *STATISTICS*   SOURCE STATEMENTS =     20 ,PROGRAM SIZE =      606

 *STATISTICS*   NO  DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                              181K BYTES OF CORE NOT USED
```

```
LEVEL  21.6  (DEC 72)                    OS/360  FORTRAN H                                   DATE  76.324/21.47.59

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                                  SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
      ISN 0002                   SUBROUTINE TDIST(AS,NENTER,IENTER,PATH,DIST,ENT,NPLANE,IENT)
                       C         SUBROUTINE TDIST CALCULATES DISTANCE TO THE CLOUD THE PHOTON
                       C         CAN ENTER IN TRACK
      ISN 0003                   DIMENSION AS(10),IENTER(10),DIST(10),ENT(10,3)
      ISN 0004                   DI=1.0E+10
      ISN 0005                   INDC=-1
      ISN 0006                   IENT=0
      ISN 0007                   IF(NENTER.LE.0)GO TO 99
      ISN 0009                   DO 1 J=1,NENTER
      ISN 0010                   IF(DI.GE.1.0E+10) GO TO 2
      ISN 0012                   IF(AS(IENTER(J)).GT.DI) GO TO 1
      ISN 0014               2   I=IENTER(J)
      ISN 0015                   CALL PLANE(I,INDC,ENT,NPLANE,DIST)
      ISN 0016                   IF(NPLANE.LE.0) GO TO 1
      ISN 0018                   IF(DIST(I).GT.PATH.OR.DIST(I).GT.DI) GO TO 1
      ISN 0020                   IENT=I
      ISN 0021                   DI=DIST(I)
      ISN 0022               1   CONTINUE
      ISN 0023              99   CONTINUE
      ISN 0024                   RETURN
      ISN 0025                   END

                         *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****           PAGE 002

 SYMBOL   INTERNAL STATEMENT NUMBERS
 I         0014  0015  0018  0018  0020  0021
 J         0009  0012  0014
 AS        0002  0003  0012
 DI        0004  0010  0012  0018  0021
 ENT       0002  0003  0015
 DIST      0002  0003  0015  0018  0018  0021
 IENT      0002  0006  0020
 INDC      0005  0015
 PATH      0002  0018
 PLANE     0015
 TDIST     0002
 IENTER    0002  0003  0012  0014
 NENTER    0002  0007  0009
 NPLANE    0002  0015  0016

                         *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****           PAGE 003

  LABEL   DEFINED   REFERENCES
     1     0022      0009  0012  0016  0018
     2     0014      0010
    99     0023      0007

                                                 /  TDIST /   SIZE OF PROGRAM 00027A HEXADECIMAL BYTES PAGE 004

     NAME    TAG     TYPE  ADD.        NAME    TAG     TYPE  ADD.        NAME    TAG   TYPE  ADD.        NAME    TAG    TYPE  ADD.
        I SFA        I*4   000098         J SF         I*4   00009C         AS     XR  R*4   000000         DI S          R*4   0000A0
      ENT SFA XR     R*4   000000      DIST SFA XR     R*4   000000       IENT S       I*4   0000A4       INDC SFA        I*4   0000A8
     PATH            R*4   0000AC     PLANE SF  XF     R*4   000000      TDIST         R*4   000000     IENTER F  XR    I*4   000000
   NENTER F          I*4   0000B4    NPLANE SFA        I*4   0000B8

     LABEL   ADDR                 LABEL   ADDR                 LABEL   ADDR                 LABEL   ADDR          PAGE 005

       2   000160                   1   0001A8                  99   000182

 *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

 *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

 *STATISTICS*    SOURCE STATEMENTS =     24 ,PROGRAM SIZE =      634

 *STATISTICS*   NO  DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                                   131K BYTES OF CORE NOT USED
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
      COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,
                         SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
ISN 0002              SUBROUTINE FIXALL(UX,UY,UZ,CX,CY,CZ,UN,VN,WN,ANGLE,  A,B,C)
               C**
               C**       S U B R O U T I N E    F I X A L L
               C**
               C**       THIS SUBROUTINE DETERMINES THE NORMAL TO THE SCATTERING PLANE
               C**       AND COMPUTES THE ANGLE THROUGH WHICH THE INCIDENT STOKES
               C**       VECTOR MUST BE ROTATED.
               C**
ISN 0003              IF(CX.NE.0.) GO TO 2
ISN 0005              IF(CY.NE.0.) GO TO 3
ISN 0007              IF(CZ.NE.0.) GO TO 4
ISN 0009            2 IF(UX.EQ.0.)GO TO 5
ISN 0011              SK=UX/CX
ISN 0012              IF((CY*SK).EQ.UY.AND. (CZ*SK).EQ.UZ)GO TO 1
ISN 0014              GO TO 5
ISN 0015            3 IF(UY.EQ.0.)GO TO5
ISN 0017              SK=UY/CY
ISN 0018              IF((CX*SK).EQ.UX.AND.(CZ*SK).EQ.UZ)GO TO 1
ISN 0020              GO TO 5
ISN 0021            4 IF(UZ.EQ.0.) GO TO 5
ISN 0023              SK=UZ/CZ
ISN 0024              IF((CX*SK).EQ.UX.AND.(CY*SK).EQ.UY) GO TO 1
ISN 0026            5 CONTINUE
ISN 0027              CALL NORMAL(UX,UY,UZ,CX,CY,CZ,A,B,C)
ISN 0028              COSAN=A*UN+B*VN+C*WN
ISN 0029              IF(COSAN.GT.1.) COSAN=1.
ISN 0031              IF(COSAN.LT.-1.) COSAN=-1.
ISN 0033              ANGLE = ARCOS(COSAN)
ISN 0034              IF((CX*(B*WN-C*VN)+CY*(C*UN-A*WN)+CZ*(A*VN-B*UN)).LT.0.)ANGLE=-ANG
                     1LE
ISN 0036              RETURN
ISN 0037            1 ANGLE=0.
ISN 0038              A=UN
ISN 0039              B=VN
ISN 0040              C=WN
ISN 0041              RETURN
ISN 0042              END
```

166

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G***** PAGE 002

```
SYMBOL   INTERNAL STATEMENT NUMBERS
A        0002  0027  0028  0034  0034  0038
B        0002  0027  0028  0034  0034  0039
C        0002  0027  0028  0034  0040
CX       0002  0003  0011  0018  0024  0027  0034
CY       0002  0005  0012  0017  0024  0027  0034
CZ       0002  0007  0012  0018  0023  0027  0034
SK       0011  0012  0012  0017  0018  0018  0023  0024  0024
UN       0002  0028  0034  0034  0038
UX       0002  0009  0011  0018  0024  0027
UY       0002  0012  0015  0017  0024  0027
UZ       0002  0012  0018  0021  0023  0027
VN       0002  0028  0034  0034  0039
WN       0002  0028  0034  0034  0040
ANGLE    0002  0033  0034  0034  0037
ARCOS    0033
COSAN    0028  0029  0029  0031  0031  0033
FIXALL   0002
NORMAL   0027
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G***** PAGE 003

```
LABEL   DEFINED   REFERENCES
  1     0037      0012  0018  0024
  2     0009      0003
  3     0015      0005
  4     0021      0007
  5     0026      0009  0014  0015  0020  0021
```

/ FIXALL / SIZE OF PROGRAM 0003A4 HEXADECIMAL BYTES PAGE 004

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	SFA	R*4	0000A8	B	SFA	R*4	0000AC	C	SFA	R*4	0000B0	CX	SFA	R*4	0000B4

```
      CY SFA      R*4  0000B8         CZ SFA     R*4  0000BC         SK S        R*4  0000C0          LN F       R*4  0000C4
      CX SFA      R*4  0000C8         UY SFA     R*4  0000CC         UZ SFA      R*4  0000D0          VN F       R*4  0000D4
      *N F        R*4  0000DE      ANGLE SF      R*4  0000DC      CCSAN SFA      R*4  0000E0       ARCCS   XF R*4  000000
   FIXALL         R*4  0000E4     NORMAL SF  XF  I*4  000000

   LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR           PAGE 005

       2   00011A                3   00014E                4   000182                5   000182
       1   00027E

 *OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

 *OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

 *STATISTICS*     SOURCE STATEMENTS =        41 ,PROGRAM SIZE =        932

 *STATISTICS*  NO  DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                                    177K BYTES OF CORE NOT USED

 LEVEL  21.6  (DEC 72)                         OS/360  FORTRAN H                              DATE  76.324/21.48.22

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
    ISN 0002              SUBROUTINE NORMAL(CX1,CY1,CZ1,CX2,CY2,CZ2,CX,CY,CZ)
                    C**
                    C**       S U B R O U T I N E   N O R M A L
                    C**
                    C**       THIS SUBROUTINE DETERMINES THE DIRECTION COSINES OF THE
                    C**       NORMAL TO A PLANE DEFINED BY 2 DIRECTIONS.
                    C**
    ISN 0003              U=CY1*CZ2-CZ1*CY2
    ISN 0004              V=CZ1*CX2-CX1*CZ2
    ISN 0005              W=CX1*CY2-CX2*CY1
    ISN 0006              T=SQRT(U*U+V*V+W*W)
    ISN 0007              CX=U/T
    ISN 0008              CY=V/T
    ISN 0009              CZ=W/T
    ISN 0010              RETURN
    ISN 0011              END

                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****             PAGE 002

  SYMBOL   INTERNAL STATEMENT NUMBERS
  T        0006  0007  0008  0009
  U        0003  0006  0006  0007
  V        0004  0006  0006  0008
  W        0005  0006  0006  0009
  CX       0002  0007
  CY       0002  0008
  CZ       0002  0009
  CX1      0002  0004  0005
  CX2      0002  0004  0005
  CY1      0002  0003  0005
  CY2      0002  0003  0005
  CZ1      0002  0003  0004
  CZ2      0002  0003  0004
  SQRT     0006
  NORMAL   0002

                                   /  NORMAL /     SIZE OF PROGRAM 0001E6 HEXADECIMAL BYTES PAGE 003

       NAME    TAG   TYPE  ADD.       NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.
          T SF       R*4  000078        U SFA      R*4  00007C        V SFA      R*4  000080        W SFA      R*4  000084
         CX S        R*4  000088       CY S        R*4  00008C       CZ S        R*4  000090      CX1 F       R*4  000094
        CX2 F        R*4  000098      CY1 F        R*4  00009C      CY2 F        R*4  0000A0      CZ1 F       R*4  0000A4
        CZ2 F        R*4  0000A8     SQRT    XF    R*4  000000   NORMAL          I*4  0000AC

 *OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

 *OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

 *STATISTICS*     SOURCE STATEMENTS =        10 ,PROGRAM SIZE =        486

 *STATISTICS*  NO  DIAGNOSTICS GENERATED
```

ORIGINAL PAGE IS
OF POOR QUALITY

****** END OF COMPILATION ******   181K BYTES OF CORE NOT USED

```
LEVEL  21.6  (DEC 72)                    OS/360  FORTRAN H                       DATE  76.324/21.48.31

         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=92,SIZE=0000K,
                            SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
 ISN 0002              SUBROUTINE JIM(COUT,CIN,CP,SP,CE,SB)
                 C**
                 C**     S U B R O U T I N E   J I M
                 C**
 ISN 0003              DIMENSION COUT(6)
 ISN 0004              DIMENSION CIN(6)
                 C
                 C*****************************************************************
                 C
                 C**   THIS SUBROUTINE IS THE FOCAL POINT OF THE PROGRAM .  IT COMPUTES
                 C**   THE DIRECTION COSINES AFTER SCATTERING GIVEN THE DIRECTION
                 C**   COSINES BEFORE SCATTERING, THE SCATTERING ANGLE AND THE AXIMUTH
                 C**   REFERENCED TO THE MERIDIAN.
                 C
                 C*****************************************************************
                 C
 ISN 0005              CX=CIN(4)
 ISN 0006              CY=CIN(5)
 ISN 0007              CZ=CIN(6)
 ISN 0008              COUT(1)=CIN(1)
 ISN 0009              COUT(2)=CIN(2)
 ISN 0010              COUT(3)=CIN(3)
 ISN 0011              IF(CX.EQ.0.AND.CY.EQ.0) GO TO 10
 ISN 0013              PHI=ATAN2(CY,CX)
 ISN 0014              GO TO 11
 ISN 0015         10   PHI=0.
 ISN 0016         11   SINPHI=SIN(PHI)
 ISN 0017              COSPHI=COS(PHI)
 ISN 0018              CN=CX*CX+CY*CY
 ISN 0019              CD=CN+CZ*CZ
 ISN 0020              SINTHE=SQRT(CN/CD)
 ISN 0021              BT=SB*CP
 ISN 0022              BP=SB*SP
 ISN 0023              BC=BT*CZ
 ISN 0024              CX = CB*CX-BP*SINPHI+BC*COSPHI
 ISN 0025              CY = CB*CY+BP*COSPHI+BC*SINPHI
 ISN 0026              CZ = CB*CZ            -BT*SINTHE
 ISN 0027          1   CONTINUE
 ISN 0028              COUT(4)=CX
 ISN 0029              COUT(5)=CY
 ISN 0030              COUT(6)=CZ
 ISN 0031              RETURN
 ISN 0032              END
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****   PAGE 002

SYMBOL	INTERNAL STATEMENT NUMBERS							
BC	0023	0024	0025					
BP	0022	0024	0025					
BT	0021	0023	0026					
CB	0002	0024	0025	0026				
CD	0019	0020						
CN	0018	0019	0020					
CP	0002	0021						
CX	0005	0011	0013	0018	0018	0024	0024	0028
CY	0006	0011	0013	0018	0018	0025	0025	0029
CZ	0007	0019	0019	0023	0026	0026	0030	
SB	0002	0021	0022					
SP	0002	0022						
CIN	0002	0004	0005	0006	0007	0008	0009	0010
COS	0017							
JIM	0002							
PHI	0013	0015	0016	0017				
SIN	0016							
COUT	0002	0003	0008	0009	0010	0028	0029	0030
SQRT	0020							
ATAN2	0013							
COSPHI	0017	0024	0025					
SINPHI	0016	0024	0025					
SINTHE	0020	0026						

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003
  LABEL   DEFINED   REFERENCES
    1      0027
   10      0015      0011
   11      0016      0014

                         /   JIM /   SIZE OF PROGRAM 0002EC HEXADECIMAL BYTES PAGE 004

   NAME  TAG  TYPE  ADD.      NAME  TAG  TYPE  ADD.      NAME  TAG  TYPE  ADD.      NAME  TAG  TYPE  ADD.
     DC  SF   R*4  0000A4       DP  SF   R*4  0000A8       BT  SF   R*4  0000AC       CB  F    R*4  0000B0
     CO  SFA  R*4  0000B4       CN  SFA  R*4  0000B8       CP  F    R*4  0000BC       CX  SFA  R*4  0000C0
     CY  SFA  R*4  0000C4       CZ  SF   R*4  0000C8       SB  F    R*4  0000CC       SP  F    R*4  0000D0
    CIN  F XR R*4  000000      JIM       I*4  0000D4      PHI  SFA  R*4  0000D8     COLT  S XR R*4  000000
   SQRT    XF R*4  000000      COS    XF R*4  000000      SIN    XF R*4  000000    ATAN2    XF R*4  000000
 COSPHI  SF   R*4  0000DC   SINPHI  SF   R*4  0000E0   SINTHE  SF   R*4  0000E4

   LABEL   ADDR         LABEL   ADDR         LABEL   ADDR         LABEL   ADDR         PAGE 005
     10  00018A           11  000192            1  000254 NR

*OPTIONS IN EFFECT*    NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,
*OPTIONS IN EFFECT*    SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*    SOURCE STATEMENTS =      21 ,PROGRAM SIZE =      736
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                       177K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                 OS/360  FORTRAN H                 DATE  76.324/21.48.40

        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
  ISN 0002               SUBROUTINE XSECTM(PHI,B,X,Y,N,M)
                   C**
                   C**     S U B R O U T I N E   X S E C T M
                   C**
                   C
                   C HERE WE COMPUTE THE PHASE FUNCTION FOR A SCATTERING ANGLE OF PHI.
                   C
  ISN 0003               DIMENSION X(5,100),Y(100,5)
  ISN 0004               DO 1 I=2,N
  ISN 0005               IF (PHI.LT.X(M,I)) GO TO 2
  ISN 0007             1 CONTINUE
  ISN 0008               B=Y(N,M)
  ISN 0009               RETURN
  ISN 0010             2 CONTINUE
  ISN 0011               N2=N/2
  ISN 0012               I3=I+1
  ISN 0013               I2=I
  ISN 0014               IF(I.GT.N2)I3=I-2
  ISN 0016               I1=I-1
  ISN 0017               D1=(Y(I2,M)-Y(I1,M))/(X(M,I2)-X(M,I1))
  ISN 0018               D2=((Y(I3,M)-Y(I1,M))/(X(M,I3)-X(M,I1))-D1)/(X(M,I3)-X(M,I2))
  ISN 0019               B=Y(I1,M)+(PHI-X(M,I1))*(D1+(PHI-X(M,I2))*D2)
  ISN 0020               RETURN
  ISN 0021               END

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002
  SYMBOL   INTERNAL STATEMENT NUMBERS
    B      0002  0008  0019
    I      0004  0005  0012  0013  0014  0014  0016
    M      0002  0005  0008  0017  0017  0017  0017  0018  0018  0018  0018  0018  0018  0019  0019  0019
    N      0002  0004  0008  0011
    X      0002  0003  0005  0017  0017  0018  0018  0018  0018  0019  0019
    Y      0002  0003  0008  0017  0017  0018  0018  0019
    D1     0017  0018  0019
    D2     0018  0019
    I1     0016  0017  0017  0018  0018  0019  0019
    I2     0013  0017  0017  0018  0019
    I3     0012  0014  0018  0018  0018
    N2     0011  0014
    PHI    0002  0005  0019  0019
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003

 LABEL    DEFINED    REFERENCES
   1       0007        0004
   2       0010        0005

                            /  XSECTM /    SIZE OF PROGRAM 0002C6 HEXADECIMAL BYTES PAGE 004

     NAME   TAG   TYPE  ADD.       NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.
        B S       R*4  000088        I SF       I*4  00008C        M  F       I*4  000090        N  F       I*4  000094
        X  F  XR  R*4  000000        Y  F  XR   R*4  000000       D1 SF       R*4  000098       D2 SF       R*4  00009C
       I1 SF      I*4  0000A0       I2 SF       I*4  0000A4       I3 SF       I*4  0000A8       N2 S        I*4  0000AC
      PHI  F      R*4  0000BC   XSECTM          R*4  000084

     LABEL  ADDR              LABEL  ADDR              LABEL  ADDR              LABEL  ADDR           PAGE 005

        1  000136                2  000162

 *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=92,SIZE=0000K,

 *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

 *STATISTICS*     SOURCE STATEMENTS =       26 ,PROGRAM SIZE =       710

 *STATISTICS*  NO  DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                             181K BYTES OF CORE NOT USED

 LEVEL  21.6  (DEC 72)                  OS/360  FORTRAN H                          DATE  76.324/21.48.49

           COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                              SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
      ISN 0002              SUBROUTINE ANGLEM(BETA,XX)
                     C**
                     C**      S U B R O U T I N E   A N G L E M
                     C**
                     C
                     C THIS SUBROUTINE PERFORMS A TABLE LOOK-UP FOR THE
                     C SCATTERING ANGLE GIVEN A RECTANGULARLY DISTRIBUTED NUMBER
                     C BETWEEN 0 AND 1
                     C
      ISN 0003              DIMENSION X1(5,100),Y1(5,100)
      ISN 0004              DIMENSION S11(100,5),S12(100,5,2), S22(100,5,2), S33(100,5,2)
                           1 ,S34(100,5,2), S44(100,5,2)
      ISN 0005              DIMENSION X(5,100)
      ISN 0006              DIMENSION CDF (5,100)
      ISN 0007              COMMON S11, S12, S22, S33, S34, S44, X, X1, Y1, CDF
      ISN 0008              COMMON/PARAM/IND,NSCA,NK(5),NUMK(5),KMAX,IST,WAV,FACTOR,NM
                           1,NMAX
      ISN 0009              COMMON/SCAT/M,INDIC(5),JK,IGNC
      ISN 0010              COMMON/CONST/PI,TPI
      ISN 0011              M=JK
      ISN 0012              NUM=NUMK(JK)
      ISN 0013              DO 1 I=1,NUM
      ISN 0014              IF(XX.LE.Y1(M,I)) GO TO 2
      ISN 0016            1 CONTINUE
      ISN 0017            2 IF(I.EQ.1) GO TO 3
      ISN 0019              IF(XX.EQ.1.) GO TO 4
      ISN 0021              N2=NUM/2
      ISN 0022              I3=I+1
      ISN 0023              IF(I.GT.N2)I3=I-2
      ISN 0025              I1=I-1
      ISN 0026              I2=I
      ISN 0027              D1=(X1(M,I2)-X1(M,I1))/(Y1(M,I2)-Y1(M,I1))
      ISN 0028              D2=((X1(M,I3)-X1(M,I1))/(Y1(M,I3)-Y1(M,I1))-D1)/(Y1(M,I3)-Y1(M,I2)
                           .)
      ISN 0029              BETA=X1(M,I1)+(XX-Y1(M,I1))*(D1+(XX-Y1(M,I2))*D2)
      ISN 0030            5 RETURN
      ISN 0031            3 CONTINUE
      ISN 0032              D1=X1(M,1)/Y1(M,1)
      ISN 0033              D2=(X1(M,2)/Y1(M,2)-D1)/(Y1(M,2)-Y1(M,1))
      ISN 0034              BETA=XX*(D1+(XX-Y1(M,1))*D2)
      ISN 0035              GO TO 5
      ISN 0036            4 BETA=PI
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0037          GO TO 5
ISN 0038          END

*****F-O-R-T-R-A-N   C-R-O-S-S   R-E-F-E-R-E-N-C-E   L-I-S-T-I-N-G*****        PAGE 002

SYMBOL   INTERNAL STATEMENT NUMBERS
 I       0013  0014  0017  0022  0023  0023  0025  0026
 M       0011  0014  0027  0027  0027  0027  0028  0028  0028  0028  0028  0028  0029  0029  0029  0032  0032  0033  0033
         0033  0033  0034
 N       0009
 X       0015  0007
 D1      0027  0028  0029  0032  0033  0034
 D2      0026  0029  0033  0034
 I1      0025  0027  0027  0028  0028  0029  0029
 I2      0026  0027  0027  0028  0029
 I3      0022  0023  0028  0028  0028
 JK      0019  0011  0012
 NK      0008
 NM      0008
 N2      0021  0023
 PI      0013  0036
 XX      0032  0014  0019  0029  0029  0034  0034
 X1      0033  0007  0027  0027  0028  0028  0029  0032  0033
 Y1      0033  0007  0014  0027  0027  0028  0028  0028  0028  0029  0029  0032  0033  0033  0033  0034
 CDF     0006  0007
 IND     0008
 IST     0008
 NUM     0012  0013  0021
 S11     0004  0007
 S12     0004  0007
 S22     0004  0007
 S33     0004  0007
 S34     0004  0007
 S44     0004  0007
 TPI     0010
 WAV     0008
 BETA    0032  0029  0034  0036
 IGND    0009
 KMAX    0009
 NMAX    0008
 NSCA    0008
 NUMK    0008  0012
 INDIC   0009
 ANGLEM  0002
 FACTOR  0008

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****        PAGE 003

LABEL   DEFINED   REFERENCES
  1     0016      0013
  2     0017      0014
  3     0031      0017
  4     0036      0019
  5     0030      0035  0037

            /  ANGLEM  /   SIZE OF PROGRAM 000286 HEXADECIMAL BYTES PAGE 004

  NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.
     I  SF     I*4  000090        M  SF     I*4  000094        N      C  I*4   N.R.         X      C  R*4   N.R.
    D1  SF     R*4  00009E       D2  SF     R*4  00009C       I1  SF     I*4  0000A0       I2  SF     I*4  0000A4
    I3  SF     I*4  0000A8       JK  F   C  I*4  0000B8       NK      C  I*4   N.R.        NM      C  I*4   N.R.
    N2  S      I*4  0000AC       PI  F   C  R*4  0000C0       XX  F      R*4  0000B0       X1  F   C  R*4  005DC0
    Y1  F   C  R*4  006590      CDF      C  R*4   N.R.       IND      C  I*4   N.R.       IST      C  I*4   N.R.
   NUM  SF     I*4  0000B4      S11      C  R*4   N.R.       S12      C  R*4   N.R.       S22      C  R*4   N.R.
   S33      C  R*4   N.R.       S34      C  R*4   N.R.       S44      C  R*4   N.R.       TPI      C  R*4   N.R.
   WAV      C  R*4   N.R.      BETA  S     R*4  0000B8      IGND      C  I*4   N.R.      KMAX      C  I*4   N.R.
  NMAX      C  I*4   N.R.      NSCA      C  I*4   N.R.      NUMK  F   C  I*4  00001C     INDIC      C  I*4   N.R.
ANGLEM         R*4  0000BC   FACTOR      C  R*4   N.R.

                    *****  COMMON INFORMATION  *****

   NAME OF COMMON BLOCK  *         *  SIZE OF BLOCK   007530 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
     S11   R*4    N.R.             S12   R*4    N.R.             S22   R*4    N.R.             S33   R*4    N.R.
     S34   R*4    N.R.             S44   R*4    N.R.               X   R*4    N.R.              X1   R*4   005DC0
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
   Y1       R*4    CCC530            CDF      R*4      N.R.

         NAME OF COMMON BLOCK   * PARAM*    SIZE OF BLOCK     000048 HEXADECIMAL BYTES

      VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
          IND     I*4     N.R.          NSCA     I*4     N.R.           NK     I*4     N.R.           NUMK   I*4    00001C
         KMAX     I*4     N.R.          IST      I*4     N.R.          *AV     R*4     N.R.          FACTOR  R*4     N.R.
           NM     I*4     N.R.          NMAX     I*4     N.R.

         NAME OF COMMON BLOCK   *  SCAT*    SIZE OF BLOCK     000020 HEXADECIMAL BYTES

      VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
            N     I*4     N.R.          INDIC    I*4     N.R.           JK     I*4   C00018          IGND    I*4     N.R.

         NAME OF COMMON BLOCK   * CCNST*    SIZE OF BLOCK     000008 HEXADECIMAL BYTES

      VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
           PI     R*4   000000          TPI      R*4     N.R.

    LABEL   ADDR                LABEL   ADDR                LABEL   ADDR                LABEL   ADDR          PAGE 005

       1   00015E                  2   000168                  5   000228                  3   000230
       4   00026A

  *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

  *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

  *STATISTICS*     SOURCE STATEMENTS =       37 ,PROGRAM SIZE =       694

  *STATISTICS*  NO DIAGNOSTICS GENERATED

  ****** END OF COMPILATION ******                                            177K BYTES OF CORE NOT USED

  LEVEL  21.6 (DEC 72)                         OS/360  FORTRAN H                                DATE  76.324/21.49.00

      COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                         SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
      ISN 0002             SUBROUTINE ELEMTS(BETA,S,K)
               C**
               C**         S U B R O U T I N E    E L E M T S
               C**
               C**         THIS SUBROUTINE COMPUTES THE  ALL SCATTERING MATRIX ELEMENTS
               C**         FOR THE SCATTERING ANGLE BETA.
               C**
      ISN 0003             DIMENSION S(6),X(5,100),S11(100,5),S12(100,5,2),S22(100,5,2),
                          1 S33(100,5,2),S34(100,5,2),S44(100,5,2)
      ISN 0004             DIMENSION X1(5,100),Y1(5,100)
      ISN 0005             DIMENSION CDF (5,100)
      ISN 0006             COMMON S11, S12, S22, S33, S34, S44, X, X1, Y1, CDF
      ISN 0007             COMMON/CONST/PI,TPI
      ISN 0008             COMMON/SCAT/N,INDIC(5),JK,IGND
      ISN 0009             COMMON/ACC/AC1,AC2,AC3
      ISN 0010             I=JK
      ISN 0011             IF(INDIC(JK).EQ.0)RETURN
      ISN 0013             IF(K.EQ.1)CALL XSLCIN(BETA,S(1),X,S11,N,I)
      ISN 0015             IF(K.EQ.2)S(1)=1.
      ISN 0017             CALL XS2(BETA,S(2),X,S12,N,I,K)
      ISN 0018             CALL XS2(BETA,S(3),X,S33,N,I,K)
      ISN 0019             CALL XS2(BETA,S(4),X,S34,N,I,K)
      ISN 0020             IF(INDIC(JK).NE.3)RETURN
      ISN 0022             CALL XS2(BETA,S(5),X,S22,N,I,K)
      ISN 0023             CALL XS2(BETA,S(6),X,S44,N,I,K)
      ISN 0024             RETURN
      ISN 0025             END

                   *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****         PAGE 002

  SYMBOL   INTERNAL STATEMENT NUMBERS
   I        0010  0013  0017  0018  0019  0022  0023
   K        0002  0013  0015  0017  0018  0019  0022  0023
   N        0008  0013  0017  0018  0019  0022  0023
   S        0002  0003  0013  0015  0017  0018  0019  0022  0023
   X        0003  0006  0013  0017  0018  0019  0022  0023
   JK       0008  0010  0011  0020
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
PI        0007
X1        0014   0006
Y1        0024   0006
AC1       0009
AC2       0009
AC3       0009
CDF       0008   0006
S11       0003   0006   0013
S12       0003   0006   0017
S22       0003   0006   0022
S33       0003   0006   0018
S34       0003   0006   0019
S44       0003   0006   0023
TPI       0007
XS2       0017   0018   0019   0022   0023
BETA      0002   0013   0017   0018   0019   0022   0023
IGND      0008
INDIC     0008   0011   0020
ELEMTS    0002
XSECTM    0013
```



```
                                       /  ELEMTS /     SIZE OF PROGRAM 0002EC HEXADECIMAL BYTES PAGE 003

     NAME    TAG   TYPE  ADD.        NAME    TAG   TYPE  ADD.        NAME    TAG   TYPE  ADD.        NAME    TAG    TYPE  ADD.
        I SFA      I*4   000144         K SFA      I*4   000148         N SFA  C   I*4   000000         S SFA XR   R*4   000000
        X SFA  C   R*4   0055F0        JK  F   C   I*4   000018        PI      C   R*4   N.R.          X1      C   R*4   N.R.
       Y1      C   R*4   N.R.         AC1      C   R*4   N.R.         AC2      C   R*4   N.R.          AC3     C   R*4   N.R.
      CDF      C   R*4   N.R.         S11 SFA  C   R*4   000000       S12 SFA  C   R*4   000700        S22 SFA  C   R*4   001770
      S33 SFA  C   R*4   002710       S34 SFA  C   R*4   003600       S44 SFA  C   R*4   004650        TPI      C   R*4   N.R.
      XS2 SF  XF   R*4   000000      BETA SFA      R*4   00014C      IGND      C   I*4   N.R.          INDIC    C   I*4   000004
   ELEMTS          R*4   000130    XSECTM SF  XF   R*4   000000

                                   *****  COMMON INFORMATION  *****

      NAME OF COMMON BLOCK  *      *   SIZE OF BLOCK     007530 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
        S11   R*4   000000            S12   R*4   000700            S22   R*4   001770            S33   R*4   002710
        S34   R*4   003600            S44   R*4   004650            X     R*4   0055F0            X1    R*4   N.R.
        Y1    R*4   N.R.              CDF   R*4   N.R.

      NAME OF COMMON BLOCK  * CONST*   SIZE OF BLOCK     000008 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
        PI    R*4   N.R.              TPI   R*4   N.F.

      NAME OF COMMON BLOCK  *  SCAT*   SIZE OF BLOCK     000020 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
        N     I*4   000000            INDIC I*4   000004            JK    I*4   000018            IGND  I*4   N.R.

      NAME OF COMMON BLOCK  *   ACC*   SIZE OF BLOCK     00000C HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
        AC1   R*4   N.R.              AC2   R*4   N.F.              AC3   R*4   N.R.

 *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

 *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,IC,XREF

 *STATISTICS*     SOURCE STATEMENTS =       24 ,PROGRAM SIZE =       750

 *STATISTICS*  NO DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                                 177K BYTES OF CORE NOT USED

 LEVEL  21.6  (DEC 72)                        OS/360  FORTRAN H                          DATE  76.324/21.49.07

       COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,
                          SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,IC,XREF
   ISN 0002              SUBROUTINE XS2(PHI,B,X,Y,N,M,K)
                 C**
                 C**         S U B R O U T I N E   X S 2
                 C**
```

```
                      C**       THIS SUBROUTINE COMPUTES PHASE FUNCTIONS BY TABLE LOOK-UP
                      C**       AND INTERPOLATION.
                      C**
       ISN 0003                 DIMENSION X(5,100),Y(100,5,2)
       ISN 0004                 DO 1 I=2,N
       ISN 0005                 IF(PHI.LT.X(M,I)) GO TO 2
       ISN 0007               1 CONTINUE
       ISN 0008                 B=Y(N,M,K)
       ISN 0009                 RETURN
       ISN 0010               2 CONTINUE
       ISN 0011                 N2=N/2
       ISN 0012                 I3=I+1
       ISN 0013                 IF(I.GT.N2)I3=I-2
       ISN 0015                 I1=I-1
       ISN 0016                 I2=I
       ISN 0017                 D1=(Y(I2,M,K)-Y(I1,M,K))/(X(M,I2)-X(M,I1))
       ISN 0018                 D2=((Y(I3,M,K)-Y(I1,M,K))/(X(M,I3)-X(M,I1))-D1)/(X(M,I3)-X(M,I2))
       ISN 0019                 B=Y(I1,M,K)+(PHI-X(M,I1))*(D1+(PHI-X(M,I2))*D2)
       ISN 0020                 RETURN
       ISN 0021                 END

                 *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****        PAGE 002
  SYMBOL  INTERNAL STATEMENT NUMBERS
  B       0002  0008  0019
  I       0004  0005  0012  0013  0013  0015  0016
  K       0002  0008  0017  0017  0018  0018  0019
  M       0002  0005  0008  0017  0017  0017  0017  0018  0018  0018  0018  0018  0018  0019  0019  0019
  N       0002  0004  0008  0011
  X       0002  0003  0005  0017  0017  0018  0018  0018  0018  0019  0019
  Y       0002  0003  0008  0017  0017  0018  0018  0019
  D1      0017  0018  0019
  D2      0018  0019
  I1      0015  0017  0017  0018  0018  0019  0019
  I2      0016  0017  0017  0018  0019
  I3      0012  0013  0018  0018  0018
  N2      0011  0013
  PHI     0002  0005  0019  0019
  XS2     0002

                 *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****        PAGE 003
  LABEL   DEFINED   REFERENCES
     1     0007      0004
     2     0010      0005

                                /     XS2 /     SIZE OF PROGRAM 000306 HEXADECIMAL BYTES PAGE 004

       NAME  TAG  TYPE  ADD.        NAME  TAG  TYPE  ADD.        NAME  TAG  TYPE  ADD.        NAME  TAG  TYPE  ADD.
          B  S    R*4   00008C         I  SF   I*4   000090         K  F    I*4   000094         M  F    I*4   000098
          N  F    I*4   00009C         X  F XR R*4   000000         Y  F XR R*4   000000        C1  SF   R*4   0000A0
         D2  SF   R*4   0000A4        I1  SF   I*4   0000A8        I2  SF   I*4   0000AC        I3  SF   I*4   0000B0
         N2  S    I*4   0000B4       PHI  F    R*4   0000B8       XS2       R*4   0000BC

      LABEL   ADDR             LABEL   ADDR             LABEL   ADDR             LABEL   ADDR        PAGE 005
        1  000148                2  00017E
  *OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
  *OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
  *STATISTICS*     SOURCE STATEMENTS =      20 ,PROGRAM SIZE =      774
  *STATISTICS*  NO DIAGNOSTICS GENERATED
  ****** END OF COMPILATION ******                                  181K BYTES OF CORE NOT USED

  LEVEL  21.6  (DEC 72)                      OS/360  FORTRAN H                          DATE  76.324/21.49.16
         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                            SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
       ISN 0002                 SUBROUTINE RENEW(COUT,JETA,C3)
                      C**
                      C**       S U B R O U T I N E   R E N E W
```

```
                C**
                C**     THIS SUBROUTINE RENEWS THE SCATTERING MATRIX AFTER A REAL
                C**     SCATTERING
                C**
ISN 0003              DIMENSION SSIN(16),COUT(6),S11(100,5),S12(100,5,2),S2
                     12(100,5,2),S33(100,5,2),S34(100,5,2),S44(100,5,2),S(6)
ISN 0004              DIMENSION X(5,100)
ISN 0005              DIMENSION X1(5,100),Y1(5,100)
ISN 0006              DIMENSION CDF (5,100)
ISN 0007              COMMON/GNDHIT/ISCAT,IRCLD
ISN 0008              COMMON/IMPCHT/IMP,IMPX,IMPJ,TA,SUN,THSBR,SDTH
ISN 0009              COMMON/PHCT/CIN(6),UN,VN,WN,JJ,SOUT(16),INCLD
ISN 0010              COMMON/SCAT/N,INDIC(5),JK,IGND
ISN 0011              CALL FIXALL(COUT(4),COUT(5),COUT(6),CIN(4),CIN(5),CIN(6),UN,VN,WN,
                     1PHI,A1,B1,C1)
ISN 0012              UN=A1
ISN 0013              VN=B1
ISN 0014              WN=C1
ISN 0015              CALL ROTATE(SOUT,SSIN,PHI)
ISN 0016              IF(ISCAT.NE.0)GO TO 10
ISN 0018              IF(INDIC(JK).EQ.4)GO TO 1
ISN 0020              KI=2
ISN 0021              IF(IMPX.NE.0)KI=1
ISN 0023              CALL ELEMTS(BETA,S,KI)
ISN 0024              IF(INDIC(JK).EQ.3)CALL GENSCA(SSIN,SOUT,S,2)
ISN 0026              IF(INDIC(JK).NE.3)CALL SCATMI(SSIN,SOUT,S,2)
ISN 0028              GO TO 2
ISN 0029            1 CALL SCATRA(SSIN,SOUT,CB,2)
ISN 0030            2 CONTINUE
ISN 0031              DO 3 I=1,6
ISN 0032            3 CIN(I) =COUT(I)
ISN 0033              RETURN
ISN 0034           10 CONTINUE
                C        RENEW GROUND SCATTERING
ISN 0035              IF(IRCLD.EQ.0)CALL LAMBRT(COUT,S,2)
ISN 0037              IF(IRCLD.NE.0)CALL GENGND(COUT,CIN,IRCOD,S,2)
ISN 0039              CALL GENSCA(SSIN,SOUT,S,2)
ISN 0040              ISCAT=0
ISN 0041              GO TO 2
ISN 0042              END
```

ORIGINAL PAGE IS OF POOR QUALITY

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****   PAGE 002

```
SYMBOL  INTERNAL STATEMENT NUMBERS
I       0031  0032  0032
N       0010
S       0003  0023  0024  0026  0035  0037  0039
X       0004
A1      0011  0012
B1      0011  0013
CB      0002  0029
C1      0011  0014
JJ      0009
JK      0010  0018  0024  0026
KI      0020  0021  0023
UN      0009  0011  0012
VN      0009  0011  0013
WN      0009  0011  0014
X1      0005
Y1      0005
CDF     0006
CIN     0009  0011  0011  0011  0032  0037
IMP     0008
PHI     0011  0015
S11     0003
S12     0003
S22     0003
S33     0003
S34     0003
S44     0003
BETA    0002  0023
COUT    0002  0003  0011  0011  0011  0032  0035  0037
IGND    0010
IMPJ    0008
IMPX    0008  0021
SDTH    0008
SOUT    0009  0015  0024  0026  0029  0039
SSIN    0003  0015  0024  0026  0029  0039
INCLD   0009
INDIC   0010  0018  0024  0026
```

```
IRCUD     0007   0035   0037   0037
ISCAT     0007   0016   0040
RENEW     0002
THSUN     000E
ELEMTS    0023
FIXALL    0011
GENGND    0037
GENSCA    0024   0039
LAMBRT    0035
ROTATE    0015
SCATMI    0026
SCATRA    0025
TAWSUN    0006

          *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****                PAGE 003

   LABEL    DEFINED    REFERENCES
     1       0025       0018
     2       0030       0028   0041
     3       0032       0031
    10       0034       0016

                                      /  RENE* /    SIZE OF PROGRAM 0003CA HEXADECIMAL BYTES PAGE 004

   NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.
      I  SF     I*4  000128        N      C  I*4   N.R.         S  SFA    R*4  00014C        X         R*4   N.R.
     A1  SFA    R*4  00012C       B1  SFA    R*4  000130       CB  SFA    R*4  000134       C1  SFA    R*4  000138
     JJ      C  I*4   N.R.        JK      C  I*4  000018       KI  SFA    I*4  00013C       UN  SFA C  R*4  000018
     VN  SFA C  R*4  00001C       WN  SFA C  R*4  000020       XI         R*4   N.R.        Y1         R*4   N.R.
    COF         R*4   N.R.       CIN  SFA C  R*4  000000      IMP      C  I*4   N.R.       PHI  SFA    R*4  000140
    S11         R*4   N.R.       S12         R*4   N.R.       S22         R*4   N.R.       S33         R*4   N.R.
    S34         R*4   N.R.       S44         R*4   N.R.      BETA  SFA    R*4  000144      COLT  SFA XR R*4  000000
   IGND      C  I*4   N.R.      IMPJ      C  I*4  000004     IMPX      C  I*4  000004      SCTH      C  R*4   N.R.
   SCUT  SFA C  R*4  000028     SSIN  SFA    R*4  000164    INCLD      C  I*4   N.R.     INDIC      C  I*4  000004
  IRCUD  SFA C  I*4  000004    ISCAT  S   C  I*4  000000    RENEW         R*4  000148     THSER      C  R*4   N.R.
 ELEMTS  SF  XF R*4  000000   FIXALL  SF  XF R*4  000000   GENGND  SF  XF R*4  000000    GENSCA  SF  XF R*4  000000
 LAMBRT  SF  XF I*4  000000   ROTATE  SF  XF R*4  000000   SCATMI  SF  XF R*4  000000    SCATRA  SF  XF R*4  000000
 TAWSUN      C  R*4   N.R.

                             *****  COMMON INFORMATION  *****

      NAME OF COMMON BLOCK  *GNCHIT*   SIZE OF BLOCK    000008 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
     ISCAT    I*4    000000        IRCUD    I*4    000004

      NAME OF COMMON BLOCK  *IMPCRT*   SIZE OF BLOCK    000018 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
      IMP     I*4     N.R.          INEX    I*4    000004         IMPJ    I*4     N.R.        TAWSUN    R*4     N.R.
     THSUR    R*4     N.R.          SCTH    R*4     N.R.

      NAME OF COMMON BLOCK  * PHOT*    SIZE OF BLOCK    00006C HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
      CIN     R*4    000000         UN      R*4    000018          VN     R*4    00001C          WN     R*4    000020
      JJ      I*4     N.R.         SCUT     R*4    000028        INCLD    I*4     N.R.

      NAME OF COMMON BLOCK  * SCAT*    SIZE OF BLOCK    000020 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
       N      I*4     N.R.        INDIC     I*4    000004          JK     I*4    000018         IGND    I*4     N.R.

   LABEL    ADDR              LABEL    ADDR              LABEL    ADDR              LABEL    ADDR              PAGE 005
      1   0002F0                 2   0002FE                 3   000306                10   00031A

*OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*     SOURCE STATEMENTS =     41 ,PROGRAM SIZE =     970
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                                177K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                      OS/360  FORTRAN H                   DATE  76.324/21.49.23

            COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                               SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
   ISN 0002             FUNCTION   FUNCT(A1,B1,C1,D1,IDIST,D)
   ISN 0003             FUNCT=0.0
   ISN 0004             IF(IDIST.EQ.1.AND.D.GE.A1)FUNCT=D1*D**(-B1)
   ISN 0006             IF(IDIST.EQ.2)FUNCT=D1*D**A1*EXP(-B1*D**C1)
   ISN 0008             IF(IDIST.EQ.3.AND.D.GT.C1)FUNCT=D1/(D-C1)*EXP(-(A1*ALOG((D-C1)
                       ./(B1-C1)))**2)
   ISN 0010             IF(IDIST.EQ.4.AND.D.GE.C1)FUNCT=D1
   ISN 0012             IF(IDIST.EQ.4.AND.D.GE.A1)FUNCT=D1*(A1/D)**B1
   ISN 0014             RETURN
   ISN 0015             END

                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****     PAGE 002

 SYMBOL   INTERNAL STATEMENT NUMBERS
 D        0002  0004  0004  0006  0006  0008  0008  0008  0010  0012  0012
 A1       0002  0004  0006  0008  0012  0012
 B1       0002  0004  0006  0008  0012
 C1       0002  0006  0008  0008  0008  0008  0010
 D1       0002  0004  0006  0008  0010  0012
 EXP      0006  0008
 ALOG     0008
 FUNCT    0002  0003  0004  0006  0008  0010  0012
 IDIST    0002  0004  0006  0008  0010  0012

                                      /  FUNCT /    SIZE OF PROGRAM 000300 HEXADECIMAL BYTES PAGE 003

      NAME   TAG   TYPE  ADD.        NAME   TAG   TYPE  ADD.        NAME   TAG   TYPE  ADD.       NAME   TAG   TYPE  ADD.
         D   FA    R*4   0000B4        A1   FA    R*4   0000B8        B1   FA    R*4   0000BC        C1   FA    R*4   0000C0
        D1   F     R*4   0000C4     FUNCT S       R*4   0000C8     IDIST         I*4   0000CC      ALOG     XF   R*4   000000
       EXP      XF R*4   0000C0    FRXPR#    XF   R*4   000000

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*     SOURCE STATEMENTS =       14 ,PROGRAM SIZE =       768
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                                181K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                      OS/360  FORTRAN H                   DATE  76.324/21.49.32

            COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                               SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
   ISN 0002             SUBROUTINE GENSCA(SSIN,SCUT,S,KS)
                  C
                  C      S U B R O U T I N E   G E N S C A
                  C
                  C   THIS SUBROUTINE ACCUMULATES A NEW (GENERAL) SCATTERING INTO
                  C   THE CUMULATIVE SCATTERING MATRIX BY POST MULTIPLICATION
                  C   (SUITABLE FOR BACKWARDS CODE)
                  C
                  C   SSIN(16) = CUMULATIVE SCATTERING MATRIX PRIOR TO SCATTERING
                  C                (INPUT)
                  C   S(6) = SCATTERING MATRIX FOR GENERAL SCATTERING
                  C   KS = INDICATOR (INPUT) (=1 FOR HYPOTHETICAL SCATTERING,
                  C          RETURN ONLY THE FIRST COLUMN OF SCUT),(=2 RETURN ALL OF SCUT)
                  C   SCUT = TRANSFORMED SCATTERING MATRIX (OUTPUT)
                  C          SCUT = SSN*S
                  C
   ISN 0003             DIMENSION SSIN(16), SCUT(16),S(6)
   ISN 0004             IF(KS.EQ.1) GO TO 20
   ISN 0006             DO 10 I=1,4
   ISN 0007             I5 = I+4
   ISN 0008             I9 = I+8
   ISN 0009             I13 = I+12
   ISN 0010             SCUT(I) = SSIN(I)*S(1)+SSIN(I5)*S(2)
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0011          SOUT(15) = SSIN(15)*S(3)+SSIN(19)*S(2)
ISN 0012          SOUT(19) = SSIN(19)*S(3)-SSIN(113)*S(4)
ISN 0013          SOUT(113) = SSIN(113)*S(6)+SSIN(19)*S(4)
ISN 0014       10 CONTINUE
ISN 0015          RETURN
ISN 0016       20 DO 21 I = 1,4
ISN 0017          IS=I+4
ISN 0018       21 SOUT(I) = SSIN(I)*S(1)+SSIN(IS)*S(2)
ISN 0019          RETURN
ISN 0020          END

               *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****       PAGE 002

SYMBOL   INTERNAL STATEMENT NUMBERS
I        0006  0007  0008  0009  0010  0010  0011  0016  0017  0018  0018
S        0002  0003  0010  0010  0011  0011  0012  0012  0013  0013  0018  0018
IS       0007  0011  0011  0011  0017  0018
I9       0008  0012  0012  0013
KS       0002  0004
I13      0009  0012  0013  0013
SOUT     0002  0003  0010  0011  0012  0013  0018
SSIN     0002  0003  0010  0010  0011  0011  0012  0012  0013  0013  0016  0018
GENSCA   0002

               *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****       PAGE 003

LABEL    DEFINED   REFERENCES
  10     0014      0006
  20     0016      0004
  21     0018      0016

                     /  GENSCA  /    SIZE OF PROGRAM 0002A0 HEXADECIMAL BYTES PAGE 004

  NAME    TAG   TYPE  ADD.      NAME   TAG     TYPE  ADD.      NAME   TAG     TYPE  ADD.      NAME   TAG     TYPE  ADD.
     I  SF      I*4   000098       S   F  XR   R*4   0000C0      IS   SF      I*4   00009C      I9   SF      I*4   0000A0
    KS          I*4   0000A4     I13   SF      I*4   0000A8    SOUT   S   XR  R*4   000000    SSIN   F   XR  R*4   000000
GENSCA          R*4   0000AC

 LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR          PAGE 005
    10   0001CE               20   0001E6               21   00020A

*OPTIONS IN EFFECT*    NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

*OPTIONS IN EFFECT*    SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

*STATISTICS*    SOURCE STATEMENTS =      19 ,PROGRAM SIZE =      672

*STATISTICS*  NO DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                             181K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                     OS/360  FORTRAN H                              DATE  76.324/21.49.42

         COMPILER-OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                            SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
ISN 0002          SUBROUTINE SCATMI(SSIN,SOUT,S,KS)
C*****
C
C       S U B R O U T I N E   S C A T M I
C
C
C     THIS SUBROUTINE ACCUMULATES A NEW SCATTERING INTO THE
C     CUMULATIVE SCATTERING MATRIX FOR MIE SCATTERING BY
C     POST-MULTIPLICATION(SUITABLE FOR BACKWARDS CODE)
C
C     SSIN(16) = INPUT CUMULATIVE SCATTERING MATRIX (INPUT)
C     S(6) = MIE SCATTERING MATRIX (INPUT)
C     SOUT(16) = SCATTERING TRANSFORM OF SSIN (OUTPUT)
C     KS = 1 IF THIS IS A HYPOTHETICAL SCATTERING INTO THE SUN
C           IN WHICH CASE THIS ROUTINE RETURNS WITH ONLY THE
C           FIRST COLUMN OF SOUT
C        = 2 REAL SCATTERING - ALL OF SOUT IS RETURNED
C                (INPUT)
C
```

```
ISN 0003        DIMENSION SSIN(16),SOUT(16),S(6)
ISN 0004        IF(KS.EQ.1) GO TO 20
ISN 0006        DO 10 I=1,4
ISN 0007        I5 = I+4
ISN 0008        I9 = I+8
ISN 0009        I13 = I+12
ISN 0010        SOUT(I) = SSIN(I)*S(1)+SSIN(I5)*S(2)
ISN 0011        SOUT(I5) = SSIN(I5)*S(1)+SSIN(I)*S(2)
ISN 0012        SOUT(I9) = SSIN(I9)*S(3)-SSIN(I13)*S(4)
ISN 0013        SOUT (I13)=SSIN(I13)*S(3)+SSIN(I9)*S(4)
ISN 0014     10 CONTINUE
ISN 0015        RETURN
ISN 0016     20 DO 21 I=1,4
ISN 0017        I5 = I+4
ISN 0018     21 SOUT(I) = SSIN(I)*S(1)+SSIN(I5)*S(2)
ISN 0019        RETURN
ISN 0020        END
```

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002

SYMBOL   INTERNAL STATEMENT NUMBERS
I        0016  0007  0008  0009  0010  0010  0011  0016  0017  0018  0018
S        0002  0003  0010  0010  0011  0011  0012  0012  0013  0013  0018  0018
I5       0007  0010  0011  0011  0017  0018
I9       0008  0012  0012  0013
KS       0002  0004
I13      0009  0012  0013  0013
SOUT     0002  0003  0010  0011  0012  0013  0018
SSIN     0002  0003  0010  0010  0011  0011  0012  0012  0013  0013  0018  0018
SCATMI   0002

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003

LABEL   DEFINED   REFERENCES
  10     0014      0006
  20     0016      0004
  21     0018      0016

                   /  SCATMI /   SIZE OF PROGRAM 000280 HEXADECIMAL BYTES PAGE 004

     NAME   TAG    TYPE  ADD.       NAME   TAG    TYPE  ADD.       NAME   TAG    TYPE  ADD.       NAME   TAG    TYPE  ADD.
        I SF       I*4   000090        S  F  XR   R*4   0000C0       I5 SF       I*4   000094       I9 SF       I*4   000098
       KS          I*4   00009C      I13 SF       I*4   0000A0     SOUT S   XR   R*4   000000     SSIN  F  XR   R*4   000000
   SCATMI          R*4   0000A4

   LABEL   ADDR              LABEL   ADDR             LABEL   ADDR             LABEL   ADDR          PAGE 005
      10  0001AE                20  0001C6               21  0001EA

*OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

*STATISTICS*    SOURCE STATEMENTS =     15 ,PROGRAM SIZE =      640

*STATISTICS*  NO DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                              181K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                  OS/360  FORTRAN H                        DATE  76.324/21.49.50

         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                            SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
ISN 0002           SUBROUTINE SCATRA (SSIN,SOUT,CS,KS)
             C
             C        S U B R O U T I N E    S C A T R A
             C
             C
             C     THIS SUBROUTINE ACCUMULATES A NEW RAYLEIGH SCATTERING
             C     INTO THE CUMULATIVE SCATTERING MATRIX BY POST-MULTIPLICATION
             C     (SUITABLE FOR BACKWARDS CODE)
             C
             C     SSIN(16) = CUMULATIVE SCATTERING MATRIX PRIOR TO SCATTERING
             C                (INPUT)
             C     CS = COSINE OF THE SCATTERING ANGLE (INPUT)
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                    C                 (INPUT)
                    C    KS = INDICATOR(INPUT) (=1, HYPOTHETICAL SCATTERING, COMPUTE ONLY
                    C         FIRST COLUMN OF SOUT AND USE SCATTERING MATRIX NOT
                    C         NORMALIZED BY S11)
                    C         (=2, REAL SCATTERING, COMPUTE ALL OF SOUT, USE
                    C         SCATTERING MATRIX NORMALIZED SO THAT S11=1)
                    C    SOUT(16) = RESULTANT CUMULATIVE SCATTERING MATRIX AFTER
                    C         RAYLEIGH SCATTERING(OUTPUT)
 ISN 0003                 DIMENSION SSIN(16),SOUT(16)
 ISN 0004                 CB2=CB*CB
 ISN 0005                 T1=0.75*(1.+CB2)
 ISN 0006                 T2=0.75*(CB2-1.)
 ISN 0007                 T3=1.5*CB
 ISN 0008                 IF(KS.EQ.1) GO TO 20
 ISN 0010                 T2=T2/T1
 ISN 0011                 T3=T3/T1
 ISN 0012                 T1=1.
 ISN 0013                 DO 10 I=1,4
 ISN 0014                 I5=I+4
 ISN 0015                 I9=I+8
 ISN 0016                 I13=I+12
 ISN 0017                 SOUT(I) = SSIN(I) + SSIN(I5)*T2
 ISN 0018                 SOUT(I5) = SSIN(I5) + SSIN(I)*T2
 ISN 0019                 SOUT(I9) = SSIN(I9)*T3
 ISN 0020                 SOUT(I13) = SSIN(I13)*T3
 ISN 0021              10 CONTINUE
 ISN 0022                 RETURN
 ISN 0023              20 DO 21 I=1,4
 ISN 0024                 I5 = I+4
 ISN 0025              21 SOUT(I) = SSIN(I)*T1+SSIN(I5)*T2
 ISN 0026                 RETURN
 ISN 0027                 END

               *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****            PAGE 002

SYMBOL  INTERNAL STATEMENT NUMBERS
I       0013  0014  0015  0016  0017  0017  0018  0023  0024  0025  0025
CB      0002  0004  0004  0007
I5      0014  0017  0018  0018  0024  0025
I9      0015  0019  0019
KS      0002  0008
T1      0005  0010  0011  0012  0025
T2      0006  0010  0010  0017  0018  0025
T3      0007  0011  0011  0019  0020
CB2     0004  0005  0006
I13     0016  0020  0020
SOUT    0002  0003  0017  0018  0019  0020  0025
SSIN    0002  0003  0017  0017  0018  0018  0019  0020  0025  0025
SCATRA  0002

               *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****            PAGE 003

  LABEL   DEFINED    REFERENCES
   10     0021       0013
   20     0023       0008
   21     0025       0023

                                         / SCATRA /   SIZE OF PROGRAM 000244 HEXADECIMAL BYTES PAGE 004

      NAME  TAG  TYPE  ADD.       NAME  TAG  TYPE  ADD.       NAME  TAG  TYPE  ADD.       NAME  TAG  TYPE  ADD.
         I  SF   I*4   000094       CB  F    R*4   000098       I5  SF   I*4   00009C       I9  SF   I*4   0000A0
        KS       I*4   0000A4       T1  SF   R*4   0000A8       T2  SF   R*4   0000AC       T3  SF   R*4   0000B0
       CB2  SF   R*4   0000B4      I13  SF   I*4   0000B8     SOUT  S  XR R*4   000000     SSIN  F  XR R*4   000000
    SCATRA       R*4   0000BC

    LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR           PAGE 005

      10   000198               20   0001AC               21   0001C0

*OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,

*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

*STATISTICS*     SOURCE STATEMENTS =      26 ,PROGRAM SIZE =      580

*STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
****** END OF COMPILATION ******                                        181K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                          OS/360  FORTRAN H                              DATE  76.324/21.50.03

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
  ISN 0002                    SUBROUTINE ROTATE (SSIN,SOUT,PHI)
                   C
                   C         S U B R O U T I N E    R O T A T E
                   C
                   C  THIS SUBROUTINE ROTATES THE CUMULATIVE SCATTERING TRANSPORT
                   C  MATRIX THROUGH AN ANGLE PHI (USING POST-MULTIPLICATION
                   C  SUITABLE FOR BACKWARDS CODE)
                   C
                   C  SSIN(16) = INPUT SCATTERING TRANSFERT MATRIX
                   C  PHI = ANGLE OF ROTATION (INPUT)
                   C  SOUT(16) = ROTATED SCATTERING TRANSFERT MATRIX (OUTPUT
                   C        = SSIN*ROT(PHI)
  ISN 0003                    DIMENSION SSIN(16),SOUT(16)
  ISN 0004                    P2=PHI*2.
  ISN 0005                    CP=COS(P2)
  ISN 0006                    SP=SIN(P2)
  ISN 0007                    DO 10 I=1,4
  ISN 0008                    I5=I+4
  ISN 0009                    I9=I+8
  ISN 0010                    I13=I+12
  ISN 0011                    SOUT(I)=SSIN(I)
  ISN 0012                    SOUT(I5)=SSIN(I5)*CP-SSIN(I9)*SF
  ISN 0013                    SOUT(I9)=SSIN(I9)*CP+SSIN(I5)*SF
  ISN 0014                 10 SOUT(I13)=SSIN(I13)
  ISN 0015                    RETURN
  ISN 0016                    END

                       *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****        PAGE 002

SYMBOL   INTERNAL STATEMENT NUMBERS
I        0007  0008  0009  0010  0011  0011
CP       0005  0012  0013
I5       0008  0012  0012  0013
I9       0009  0012  0013  0013
P2       0004  0005  0006
SP       0006  0012  0013
COS      0005
I13      0010  0014  0014
PHI      0002  0004
SIN      0006
SOUT     0002  0003  0011  0012  0013  0014
SSIN     0002  0003  0011  0012  0012  0013  0013  0014
ROTATE   0002

                       *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****        PAGE 003

  LABEL   DEFINED   REFERENCES
   10      0014       0007

                                          /  ROTATE /     SIZE OF PROGRAM 0001FC HEXADECIMAL BYTES PAGE 004

     NAME   TAG   TYPE  ADD.       NAME   TAG   TYPE  ADD.       NAME   TAG   TYPE  ADD.       NAME   TAG   TYPE  ADD.
        I SF      I*4   000094       CP SF      R*4   000098       I5 SF      I*4   00009C       I9 SF      I*4   0000A0
       P2 SFA     R*4   0000A4       SP SF      R*4   0000A8      I13 SF      I*4   0000AC      PHI F       R*4   0000B0
     SOUT S   XR  R*4   000000     SSIN F   XR  R*4   000000      SIN     XF  R*4   000000      COS     XF  R*4   000000
   ROTATE         R*4   0000B4

     LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR        PAGE 005

       10   000136

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

*STATISTICS*     SOURCE STATEMENTS =       15 ,PROGRAM SIZE =        508

*STATISTICS*  NO  DIAGNOSTICS GENERATED
```

```
****** END OF COMPILATION ******                                  181K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                     OS/360  FORTRAN H                          DATE  76.324/21.50.12

            COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                               SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
      ISN 0002                 SUBROUTINE REFLOC(CG,IRCOD)
                         C
                         C          R E F L O C
                         C
                         C            IDENTIFIES REFLECTANCE TYPE  (IRCOD) BY
                         C            LOCATING THE IMPACT POINT (CG) WITHIN THE
                         C            REFLECTANCE MAP
      ISN 0003                 COMMON/RMAP/IRPAT,IRBGD,IRSPOT,XBND,CNTRX(20),CNTRY(20),EDGEX(20),
                              *EDGEY(20)
      ISN 0004                 DIMENSION CG(2)
      ISN 0005                 IRCOD=IRBGD
      ISN 0006                 IF(IRPAT.EQ.0)RETURN
      ISN 0008                 IF(IRPAT.EQ.1.AND.(CG(1).GT.XBND))IRCOD=IRSPOT
      ISN 0010                 IF(IRPAT.EQ. 1.AND.(CG(1).LT.XBND))IRCOD=IRSPOT
      ISN 0012                 IF(IRPAT.NE.2)GO TO 99
      ISN 0014                 DO 100 I=1,NSPOT
      ISN 0015                 DX=ABS(CG(1)-CNTRX(I))
      ISN 0016                 DY=ABS(CG(2)-CNTRY(I))
      ISN 0017                 IF((DX.LE.EDGEX(I)/2.).AND.(DY.LE.EDGEY(I)/2.)) GO TO 101
      ISN 0019             100 CONTINUE
      ISN 0020                 GO TO 99
      ISN 0021             101 IRCOD=IRSPOT
      ISN 0022              99 RETURN
      ISN 0023                 END

                   *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002

SYMBOL   INTERNAL STATEMENT NUMBERS
I        0014  0015  0016  0017  0017
CG       0002  0004  0008  0010  0015  0016
DX       0015  0017
DY       0016  0017
ABS      0015  0016
XBND     0003  0008  0010
CNTRX    0003  0015
CNTRY    0003  0016
EDGEX    0003  0017
EDGEY    0003  0017
IRBGD    0003  0005
IRCOD    0002  0005  0008  0010  0021
IRPAT    0003  0006  0008  0010  0012
NSPOT    0014
IRSPOT   0003  0008  0010  0021
REFLOC   0002

                   *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003

 LABEL   DEFINED   REFERENCES
   99     0022     0012  0020
  100     0019     0014
  101     0021     0017

                     /  REFLOC /    SIZE OF PROGRAM 0001F8 HEXADECIMAL BYTES PAGE 004

   NAME   TAG   TYPE  ADD.        NAME   TAG    TYPE  ADD.       NAME   TAG    TYPE  ADD.      NAME   TAG   TYPE  ADD.
      I SFA     I*4   000088        CG   FA XR  R*4   000000       DX S         R*4   00008C      DY S        R*4   000090
   XBND     C   R*4   00000C     CNTRX   FA  C  R*4   000010    CNTRY  FA  C  R*4   000060   EDGEX      C   R*4   0000B0
  EDGEY     C   R*4   000100     IRBGD   F   C  I*4   000004    IRCOD S       I*4   000094   IRPAT      C   I*4   000000
  NSPOT  F      I*4   000098    IRSPOT   F   C  I*4   000008   REFLOC         R*4   00009C

                                     *****  COMMON INFORMATION  *****

            NAME OF COMMON BLOCK  *  RMAP*   SIZE OF BLOCK    000150 HEXADECIMAL BYTES

     VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.    VAR. NAME  TYPE  REL. ADDR.
       IRPAT    I*4   000000          IRBGD    I*4   000004         IRSPOT    I*4   000008           XBND    R*4   00000C
       CNTRX    R*4   000010          CNTRY    R*4   000060          EDGEX    R*4   0000B0          EDGEY    R*4   000100
```

```
   LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR           PAGE 005
     100  00019A               101  0001A2                99  0001A6

 *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
 *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
 *STATISTICS*   SOURCE STATEMENTS =     22,PROGRAM SIZE =      504
 *STATISTICS*  NO  DIAGNOSTICS GENERATED
 ****** END OF COMPILATION ******                                       181K BYTES OF CORE NOT USED

 LEVEL  21.6  (DEC 72)                      OS/360  FORTRAN H                         DATE  76.324/21.50.22
           COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                              SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
      ISN 0002            SUBROUTINE LAMBRT(COUT,S,KI)
                    C
                    C          L A M B R T
                    C
      ISN 0003            DIMENSION S(6),COUT(6)
      ISN 0004            S(1)=2.*COUT(6)
      ISN 0005            IF(KI.EQ.1)S(1)=2.*S(1)
      ISN 0007            DO 1 J=2,6
      ISN 0008          1 S(J)=0.
      ISN 0009            RETURN
      ISN 0010            END

                     *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002
 SYMBOL   INTERNAL STATEMENT NUMBERS
 J         0007  0008
 S         0002  0003  0004  0005  0005  0008
 KI        0002  0005
 COUT      0002  0003  0004
 LAMBRT    0002

                     *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003
  LABEL   DEFINED   REFERENCES
    1      0008       0007

                                          / LAMBRT /   SIZE OF PROGRAM 000164 HEXADECIMAL BYTES PAGE 004

     NAME   TAG   TYPE   ADD.        NAME   TAG   TYPE   ADD.        NAME   TAG   TYPE   ADD.      NAME   TAG   TYPE   ADD.
        J SF       I*4  00008C          S SF   XR   R*4  000000         KI         I*4  000090      COUT   F   XR   R*4  000000
   LAMBRT          I*4  000094

   LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR           PAGE 005
       1  000199

 *OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
 *OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
 *STATISTICS*   SOURCE STATEMENTS =      9,PROGRAM SIZE =      356
 *STATISTICS*  NO  DIAGNOSTICS GENERATED
 ****** END OF COMPILATION ******                                       181K BYTES OF CORE NOT USED

 LEVEL  21.6  (DEC 72)                      OS/360  FORTRAN H                         DATE  76.324/21.50.32
           COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                              SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
      ISN 0002            SUBROUTINE GNDREF(COUT,CIN,XTH,XPH,IFCOD)
                    C
                    C          G N D R E F
                    C
                    C       GENERATES A REFLECTION DIRECTION FROM THE GROUND FOR
```

```
              C         IRCOD=0    LAMBERTIAN GROUND
              C              =1  ROUGH FRESNEL ( GAUSSIAN SLOPE DISTRIBUTION)
              C           XTH,XPH = INPUT RANDOM NUMBERS
ISN 0003            DIMENSION COUT(6),CIN(6)
ISN 0004            COMMON/CONST/PI,TPI
ISN 0005            COMMON/FREN/FN,WSIG,WSIG2,WNG(3),ZX,ZY
ISN 0006            IF(IRCOD.NE.0)GO TO 100
              C          LAMBERTIAN REFLECTION
ISN 0008            PHI=TPI*XPH
ISN 0009            SP=SIN(PHI)
ISN 0010            CP=COS(PHI)
ISN 0011            SN=SQRT(1.-XTH*XTH)
ISN 0012            COUT(4)=SN*CP
ISN 0013            COUT(5)=SN*SP
ISN 0014            COUT(6)=XTH
ISN 0015          3 DO 2 J=1,3
ISN 0016          2 COUT(J)=CIN(J)
ISN 0017            RETURN
ISN 0018        100 CONTINUE
              C          THIS SECTION IS FOR NON-LAMBERTIAN REFLECTION
              C
              C          GENERATE SLOPES FROM GAUSSIAN DISTRIBUTION
ISN 0019        103 CONTINUE
ISN 0020            CALL GAUSS(XTH,WSIG,0.,ZX)
ISN 0021            CALL GAUSS(XPH,WSIG,0.,ZY)
ISN 0022            DN=SQRT(ZX*ZX+ZY*ZY+1.)
              C          COMPUTE NORMAL TO SLOPE
ISN 0023            WNG(1)=-ZX/DN
ISN 0024            WNG(2)=-ZY/DN
ISN 0025            WNG(3)=1./DN
ISN 0026            G=0.
ISN 0027            DO 101 J=1,3
ISN 0028            JP=J+3
ISN 0029            G=G+CIN(JP)*WNG(J)
ISN 0030        101 CONTINUE
              C          CHECK TO SEE IF SLOPE IS FEASABLE.
              C          IF NOT, TRY AGAIN
ISN 0031            IF(G.GT.0.)GO TO 103
              C          COMPUTE REFLECTION DIRECTION
ISN 0033            DO 102 J=1,3
ISN 0034            JP=J+3
ISN 0035            COUT(JP)=-2.*G*WNG(J)+CIN(JP)
ISN 0036        102 CONTINUE
ISN 0037            GO TO 3
ISN 0038            END
```

```
                *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002

SYMBOL    INTERNAL STATEMENT NUMBERS
G         0026  0029  0029  0031  0035
J         0015  0016  0016  0027  0028  0029  0033  0034  0035
CP        0010  0012
DN        0022  0023  0024  0025
FN        0005
JP        0028  0029  0034  0035  0035
PI        0004
SN        0011  0012  0013
SP        0009  0013
ZX        0005  0020  0022  0022  0023
ZY        0005  0021  0022  0024  0024
CIN       0002  0003  0016  0029  0035
COS       0010
PHI       0008  0009  0010
SIN       0009
TPI       0004  0008
WNG       0005  0023  0024  0025  0029  0035
XPH       0002  0008  0021
XTH       0002  0011  0011  0014  0020
COUT      0002  0003  0012  0013  0014  0016  0035
SQRT      0011  0022
WSIG      0005  0020  0021
GAUSS     0020  0021
IRCOD     0002  0006
WSIG2     0005
GNDREF    0002
```

```
                *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003

 LABEL    DEFINED    REFERENCES
```

```
   2    0016      0015
   3    0015      0037
 100    0018      0016
 101    0020      0027
 102    0036      0033
 103    0019      0031

                                       /  GNDREF /      SIZE OF PROGRAM 00037A HEXADECIMAL BYTES PAGE 004

      NAME    TAG   TYPE  ADD.        NAME    TAG   TYPE  ADD.        NAME    TAG   TYPE  ADD.        NAME    TAG   TYPE  ADD.
         G  SF      R*4  000000          J  SF      I*4  000000         CP  SF      R*4  000004         CN  SF      R*4  000008
        FN       C  R*4   N.R.          JP  SF      I*4  00000C         PI       C  R*4   N.R.          SN  SF      R*4  0000E0
        SP  SF      R*4  0000E4         ZX  SFA  C  R*4  000018         ZY  SFA  C  R*4  00001C        CIN  F   XR  R*4  0000C0
       PHI  SFA     R*4  0000E8        TPI  F    C  R*4  000004        *NG  SF   C  R*4  00000C        XFH  SFA     R*4  0000EC
       XTF  SFA     R*4  0000F0       COUT  S   XF  R*4  000000       *SIG  SFA  C  R*4  000004      GAUSS  SF   XF  R*4  000000
     IRCCC          I*4  0000F4      *SIG2       C  R*4   N.R.        SQRT      XF  R*4  000000        CCS      XF  R*4  000000
       SIN     XF   R*4  0000F8     GNDREF          R*4  0000F8

                              ***** COMMON INFORMATION *****

       NAME OF COMMON BLOCK  * CONST*   SIZE OF BLOCK     000008 HEXADECIMAL BYTES

    VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
         PI    R*4    N.R.             TPI   R*4   000004

       NAME OF COMMON BLOCK  *  FREN*   SIZE OF BLOCK     000020 HEXADECIMAL BYTES

    VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
         FN    R*4    N.R.            *SIG   R*4   000004          *SIG2  R*4    N.R.            *NG   R*4   00000C
         ZX    R*4   000018             ZY   R*4   00001C

    LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              PAGE 005

        3  0001E8                 2  0001F4               100  00020C               103  000212
      101  0002A2               102  0002F0

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=32,SIZE=0000K,
*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*    SOURCE STATEMENTS =       37 ,PROGRAM SIZE =       890
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                                        173K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                        OS/360  FORTRAN H                          DATE  76.324/21.50.40

         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,
                            SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
  ISN 0002            SUBROUTINE GENGND(COUT,CIN,IRCCC,S,KI)
               C
               C           G E N G N D
               C
               C           COMPUTES FRESNEL MATRIX ELEMENTS MULTIPLIED BY
               C           FACTORS APPROPRIATE TO SCATTERING
  ISN 0003            DIMENSION CIN(6),COUT(6),S(6)
  ISN 0004            COMMON/FREN/FN,*SIG,*SIG2,*NG(3),ZX,ZY
  ISN 0005            COMMON/CONST/PI,TPI
               C
               C           GENERATE ANGULAR FACTORS
  ISN 0006            COSCHI=(1.-(COUT(4)*CIN(4)+COUT(5)*CIN(5)+COUT(6)*CIN(6)))/2.
  ISN 0007            COSCHI=SQRT(COSCHI)
  ISN 0008            COSTH=-CIN(6)
  ISN 0009            D=SQRT((COUT(4)-CIN(4))**2+(COUT(5)-CIN(5))**2+(COUT(6)-CIN(6))**2
                     *)
  ISN 0010            COSTHN=(COUT(6)-CIN(6))/D
  ISN 0011            FACTR=COSCHI/COSTHN/COSTH
               C           GENERATE BASIC FRESNEL MATRIX ELEMENTS
  ISN 0012            COSTHT=SQRT(1.-(1.-COSCHI*COSCHI)/FN/FN)
  ISN 0013            RPL=(FN*COSCHI-COSTHT)/(FN*COSCHI+COSTHT)
  ISN 0014            RPP=(COSCHI-FN*COSTHT)/(COSCHI+FN*COSTHT)
               C
               C           S(1)=S11   S(2)=S12   S(3)=S33   S(4)=0   S(5)=S22   S(6)=S44
  ISN 0015            S(1)=(RPL*RPL+RPP*RPP)/2.
```

```
ISN 0016          S(2)=(RPL*RPL-RPP*RPP)/2.
ISN 0017          S(3)=RPL*RPP
ISN 0018          S(4)=0.
ISN 0019          S(5)=S(1)
ISN 0020          S(6)=S(3)
ISN 0021          IF(KI.NE.1)GO TO 100
          C            GENERATE PROBABILITY FACTOR FOR SAMPLING
ISN 0023          DM=COUT(6)-CIN(6)
ISN 0024          FEXP=1.
ISN 0025          IF(DM.EQ.0.)GO TO 20
ISN 0027          GZX=(-COUT(4)+CIN(4))/DM
ISN 0028          GZY=(CIN(5)-COUT(5))/DM
ISN 0029          FEXP=(GZX*GZX+GZY*GZY)/WSIG2
ISN 0030          IF(FEXP.GT.75.)FEXP=75.
ISN 0032          FEXP=EXP(-FEXP)
ISN 0033       20 CONTINUE
ISN 0034          FEXP=FEXP/PI/WSIG2
ISN 0035          FACTR=FACTR*FEXP
ISN 0036          FACTR=FACTR/4./COSTHN**3/COSCHI
ISN 0037          FACTR=4.*PI*FACTR
ISN 0038      100 CONTINUE
ISN 0039          DO 101 J=1,6
ISN 0040          S(J)=S(J)*FACTR
ISN 0041      101 CONTINUE
ISN 0042          RETURN
ISN 0043          END
```

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****        PAGE 002

SYMBOL   INTERNAL STATEMENT NUMBERS
D        0009  0010
J        0039  0040  0040
S        0002  0003  0015  0016  0017  0018  0019  0019  0020  0020  0040  0040
DM       0023  0025  0027  0028
FN       0004  0012  0012  0013  0013  0014  0014
KI       0002  0021
PI       0005  0034  0037
ZX       0004
ZY       0004
CIN      0002  0003  0006  0006  0006  0006  0009  0009  0009  0010  0023  0027  0028
EXP      0032
GZX      0027  0029  0029
GZY      0028  0029  0029
RPL      0013  0015  0015  0016  0016  0017
RPP      0014  0015  0015  0016  0016  0017
TPI      0005
WNG      0004
COUT     0002  0003  0006  0006  0006  0009  0009  0009  0010  0023  0027  0028
FEXP     0024  0029  0030  0030  0032  0032  0034  0034  0035
SQRT     0007  0009  0012
WSIG     0004
COSTH    0006  0011
FACTR    0011  0035  0035  0036  0036  0037  0037  0040
IRCOD    0002
WSIG2    0004  0029  0034
COSCHI   0006  0007  0007  0011  0012  0012  0013  0013  0014  0014  0036
COSTHN   0010  0011  0036
COSTHT   0012  0013  0013  0014  0014
GENGND   0002
```

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****        PAGE 003

LABEL   DEFINED   REFERENCES
 20     0033      0025
100     0038      0021
101     0041      0039
```

```
      /  GENGND /      SIZE OF PROGRAM 000442 HEXADECIMAL BYTES PAGE 004

  NAME    TAG    TYPE  ADD.      NAME    TAG    TYPE  ADD.      NAME    TAG    TYPE  ADD.      NAME   TAG    TYPE  ADD.
     D SF        R*4  0000D4        J SF        I*4  0000B8        S SF   XR   R*4  000000       DM SF        R*4  0000BC
    FN  FA  C    R*4  000000       KI           I*4  0000C0       PI  F    C   R*4  000000       ZX       C   R*4  N.R.
    ZY      C    R*4  N.R.        CIN  FA XR    R*4  000000      GZX SF        R*4  0000C4      GZY SF       R*4  0000C8
   RPL SF        R*4  0000CC      RPP SF        R*4  0000D0      TPI       C   R*4  N.R.        WNG      C   R*4  N.R.
  COUT  FA XR    R*4  000000     FEXP SFA       R*4  0000D4     WSIG       C   R*4  N.R.      COSTH SF      R*4  000008
 FACTR SF        R*4  0000DC    IRCOD           I*4  0000E0    WSIG2  F    C   R*4  0000C8      EXP     XF   R*4  000000
  SQRT      XF   R*4  000000   COSCHI SFA       R*4  0000E4   COSTHN SF        R*4  0000E8   COSTHT SF      R*4  0000EC
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
                         *****  COMMON INFORMATION   *****

      NAME OF COMMON BLOCK  *  FREN*    SIZE OF BLOCK    00002C HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
        FN    R*4   000000            *SIG   R*4   N.R.              *SIG2  R*4   000008            *NG    R*4   N.R.
        2X    R*4   N.R.              2Y     R*4   N.R.

      NAME OF COMMON BLOCK  *  CONST*   SIZE OF BLOCK    000008 HEXADECIMAL BYTES

   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
        PI    R*4   000000            TPI    R*4   N.R.

  LABEL   ADDR           LABEL   ADDR           LABEL   ADDR           LABEL   ADDR          PAGE 005
    20   000360            100   000384           101   000304

 *OPTIONS IN EFFECT*    NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,

 *OPTIONS IN EFFECT*    SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

 *STATISTICS*    SOURCE STATEMENTS =       42 ,PROGRAM SIZE =      1090

 *STATISTICS*  NO DIAGNOSTICS GENERATED

 ****** END OF COMPILATION ******                            173K BYTES OF CORE NOT USED

 LEVEL  21.6  (DEC 72)                     OS/360  FORTRAN H                     DATE  76.324/21.50.49

        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
  ISN 0002           SUBROUTINE TAU(VSAMP2,VSAMP3,XMC,XMX,IND,IFL)
               C
               C         T A B
               C
               C      THIS SUBROUTINE TABULATES STANDARD DEVIATIONS OF THE MEANS
               C      SQRT(AVG(V**2)-AVG(V)**2)=SIGMA
               C
  ISN 0003           INTEGER CC(4)
  ISN 0004           DIMENSION FITIT(2,2)
  ISN 0005           DIMENSION VSFT(15)
  ISN 0006           DIMENSION VSAMP2(4,5,3,1,50),VSAMP3(4,5,3,1,50)
  ISN 0007           DIMENSION VAV(3),VSIG(3)
  ISN 0008           DIMENSION VSF(3)
  ISN 0009           DIMENSION VAVJ(15),VSIGJ(15),VCOR(15,15)
  ISN 0010           COMMON/RMAP/IMPAT,IMBGD,IRSECT,XEND,CNTRX(20),CNTRY(20),EDGEX(20),
                    *EDGEY(20)
  ISN 0011           COMMON/CTAB/VSAMP4(4,15,15,2),VSAMP5(4,15,2)
  ISN 0012           COMMON/GND/NALB,ALB(50),CS(2)
  ISN 0013           COMMON/SCL/NSCL,WSUN(11,15,3),LS(15),VS(15),WS(15)
  ISN 0014           COMMON/CONST/PI,TPI
  ISN 0015           COMMON/NORM/SOLC
  ISN 0016           DATA FITIT/4HINTN,4HSITY,4H  FL,4HUX  /
  ISN 0017           DATA CC/1HI,1HQ,1HU,1HV/
  ISN 0018       601 FORMAT(1H0,50X,'LINE ',I2)
  ISN 0019       610 FORMAT(1H0,120(1H*)/1H0,'RESULTS FOR GROUND ALBEDO')
  ISN 0020       620 FORMAT(1H0,30X,'STATISTICS FOR STOKES PARAMETER ',A1)
  ISN 0021       630 FORMAT(1H+,'SUN NO.',11X,'DIRECT SUN SAMPLE',25X,2A4,35X,2A4/1H ,
                    *3(11X,'MEAN',10X,'SIGMA',4X))
  ISN 0022       631 FORMAT(1H0,53X,'SINGLE ',34X,'MULTIPLE ')
  ISN 0023       632 FORMAT(1H0,53X,'UPWARD ',31X,'DOWNWARD ')
  ISN 0024       640 FORMAT(1H ,2X,I2,7X,5(E14.7,5X),E14.7)
  ISN 0025       650 FORMAT(1H+,'SUN NO.',10X,'DIRECT SUN',27X,7X,2A4,22X,9X,2A4/
                    *1H ,7X,3(2X,'SIGMA**2',11X,'STANDARD ERROR',3X))
  ISN 0026       651 FORMAT(1H0,54X,'SINGLE',30X,'MULTIPLE')
  ISN 0027       652 FORMAT(1H0,54X,'UPWARD',30X,'DOWNWARD')
  ISN 0028       670 FORMAT(1H0,6X,5HSOLAR,5X,5HTOTAL/1H ,6X,6HZENITH,4X,8HSTANDARD/
                    *1H ,5HSUN,3X,6HCOSINE,4X,5HERROR//)
  ISN 0029       671 FORMAT(15(1H ,I2,3X,F6.3,4X,E14.7/))
  ISN 0030       700 FORMAT(1H0,12X,24HCORRELATION COEFFICIENTS/1H ,20X,10(1H*)/1H ,2X,
                    *1H*/1H ,7HSUN*SUN/1H ,4X,1H*,3X,I2,14(6X,I2))
  ISN 0031       701 FORMAT(1H ,I2,4X,F6.3,14(2X,F6.3))
  ISN 0032       627 FORMAT(1H0,'RESULTS FOR ALL ',I2,' ALBEDO PATTERNS ARE SIMILAR')
  ISN 0033           FACT=.25
  ISN 0034           FACT=FACT*SOLC
```

```
      XN=XMC-1.
      XNN=XMC/XN
      DO 1 KK=1,2
      IF(KK.EQ.2)GO TO 1
      IF(IND.NE.1.AND.KK.EQ.2)GO TO 1
      WRITE(6,601)KK
      XNORM=FACT/PI
      XNORM=XNORM*XMX
      XNORM2=XNORM**2
      NALEL=NALE
      IF((IREGD.EQ.1).AND.(IRSFCT.EQ.1))NALEL=1
      DO 10 IALB=1,NALEL
C     WRITE ALBEDO TITLE
      WRITE(6,610)
      NALB=-IALB
      CALL ALBEDO(NALB,ALOPT)
      IF(NALEL.EQ.1)WRITE(6,627)NALE
      DO 20 IO=1,4
      IF((IND.EQ.5.OR.IND.EQ.7).AND.IO.GT.1)GO TO 20
      WRITE(6,620)CC(IO)
      IF(IFL.EQ.1)WRITE(6,631)
      IF(IFL.EQ.2)WRITE(6,632)
      WRITE(6,630)FITIT(1,IFL),FITIT(2,IFL),FITIT(1,IFL),FITIT(2,IFL)
      DO 30 IS=1,NSCL
      DO 40 NSC=1,3
      VAV(NSC)=VSAMP2(IO,IS,NSC,KK,IALB)*XNORM
      VSIG(NSC)=VSAMP3(IO,IS,NSC,KK,IALE)*XNORM2
      VSIG(NSC)=XNN*(VSIG(NSC)*XMC-VAV(NSC)*VAV(NSC))
      IF(VSIG(NSC).LE.0.)VSIG(NSC)=0.
      VSIG(NSC)=SQRT(VSIG(NSC))
   40 CONTINUE
      WRITE(6,640)IS,(VAV(NSC),VSIG(NSC),NSC=1,3)
   30 CONTINUE
      IF(IFL.EQ.1)WRITE(6,651)
```

PAGE 002

```
      IF(IFL.EQ.2)WRITE(6,652)
      WRITE(6,650)FITIT(1,IFL),FITIT(2,IFL),FITIT(1,IFL),FITIT(2,IFL)
      DO 50 IS=1,NSCL
      VSET(IS)=0.
      DO 60 NSC=1,3
      VAV(NSC)=VSAMP2(IO,IS,NSC,KK,IALB)*XNORM
      VSIG(NSC)=VSAMP3(IO,IS,NSC,KK,IALE)*XNORM2
      VSIG(NSC)=     (XNN*(VSIG(NSC)*XMC-VAV(NSC)*VAV(NSC)))
      VSE(NSC)=VSIG(NSC)/XMC
      IF(VSE(NSC).LE.0.)VSE(NSC)=0.
      VSE(NSC)=SQRT(VSE(NSC))
      VSET(IS)=VSET(IS)+VSIG(NSC)/XMC
   60 CONTINUE
      IF(VSET(IS).LE.0.)VSET(IS)=0.
      VSET(IS)=SQRT(VSET(IS))
      WRITE(6,640)IS,(VSIG(NSC),VSE(NSC),NSC=1,3)
   50 CONTINUE
      WRITE(6,670)
      WRITE(6,671)(IS,WS(IS),VSET(IS),IS=1,NSCL)
C
C     CORRELATION COEFFICIENTS
C
      IF(IALB.NE.1)GO TO 100
      WRITE(6,700)(IS,IS=1,NSCL)
      DO 101 IS=1,NSCL
      VAVJ(IS)=VSAMP2(IO,IS,1,KK,1)+VSAMP2(IO,IS,2,KK,1)+VSAMP2(IO,IS,3,
     *KK,1)
      VSIGJ(IS)=XNN*(VSAMP5(IO,IS,KK)*XMC-VAVJ(IS)*VAVJ(IS))
  101 CONTINUE
      DO 102 IS=1,NSCL
      DO 103 JS=1,IS
      VCOR(IS,JS)=XNN*(VSAMP4(IO,IS,JS,KK)*XMC-VAVJ(IS)*VAVJ(JS))
      VSIGD=SQRT(VSIGJ(IS)*VSIGJ(JS))
      IF(VSIGD.EQ.0.)VCOR(IS,JS)=1.
      IF(VSIGD.NE.0.)VCOR(IS,JS)=VCOR(IS,JS)/VSIGD
  103 CONTINUE
      WRITE(6,701)IS,(VCOR(IS,JS),JS=1,IS)
  102 CONTINUE
  100 CONTINUE
   20 CONTINUE
   10 CONTINUE
    1 CONTINUE
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
ISN 0121          RETURN
ISN 0122          END

                        *****FORTRAN  CROSS  REFERENCE  LISTING*****                 PAGE 003

SYMBOL   INTERNAL STATEMENT NUMBERS
CC       0003  0017  0056
CG       0012
IO       0055  0056  0058  0066  0067  0080  0084  0103  0102  0103  0104  0108
IS       0064  0066  0067  0073  0080  0081  0083  0084  0090  0090  0092  0092  0094  0094  0095  0098  0098  0098  0098
         0098  0101  0101  0101  0102  0103  0103  0103  0103  0104  0104  0104  0104  0106  0107  0108  0108  0108  0109
         0110  0112  0112  0115  0115  0115
JS       0107  0108  0108  0108  0109  0110  0112  0112  0115  0115  0115
KK       0037  0038  0040  0042  0066  0067  0083  0084  0103  0103  0103  0104  0108
PI       0014  0043
US       0013
VS       0013
WS       0013  0056
XN       0035  0036
ALB      0012
IFL      0002  0059  0061  0063  0063  0063  0063  0075  0077  0079  0079  0079  0079
IND      0002  0040  0056  0056
NSC      0065  0066  0066  0067  0067  0068  0068  0068  0068  0069  0069  0071  0071  0073  0073  0073  0073  0082  0083
         0083  0084  0084  0085  0085  0085  0085  0086  0086  0087  0087  0089  0089  0090  0095  0095  0095  0095
TAU      0002
TPI      0014
VAV      0007  0066  0068  0068  0073  0083  0085  0085
VSE      0008  0066  0067  0067  0089  0089  0095
XMC      0002  0035  0036  0068  0085  0086  0090  0104  0108
XMX      0002  0044
XNN      0036  0068  0088  0104  0108
FACT     0033  0034  0034  0043
IALU     0049  0051  0066  0067  0083  0084  0099
MALU     0051  0052
NALU     0012  0046  0053
NSOL     0013  0064  0080  0098  0101  0102  0106
SOLC     0015  0034
SORT     0071  0089  0094  0109
VAVJ     0009  0103  0104  0104  0108  0108
VCCR     0009  0108  0110  0112  0112  0113
VSET     0005  0081  0090  0090  0092  0092  0094  0094  0098
VSIG     0007  0067  0068  0068  0069  0069  0071  0071  0073  0084  0085  0085  0086  0090  0095
WSUN     0013
XBNO     0010
ALEPT    0052
CNTRX    0010
CNTRY    0010
CDGEX    0010
EDGEY    0010
FITIT    0004  0016  0063  0063  0063  0063  0079  0079  0079  0079
IPEGD    0010  0047
IRPAT    0010
NALUL    0046  0047  0049  0053
VSIGD    0109  0110  0112  0112
VSIGJ    0009  0104  0109  0109
XNORM    0043  0044  0044  0045  0066  0083
ALBEDO   0052
IRSPUT   0012  0047
VSAMP2   0002  0066  0066  0083  0103  0103  0103
VSAMP3   0002  0066  0067  0084
VSAMP4   0011  0108
VSAMP5   0011  0104
XNORM2   0045  0067  0084

                        *****FORTRAN  CROSS  REFERENCE  LISTING*****                 PAGE 004

LABEL    DEFINED    REFERENCES
   1      0120      0037  0038  0040
  10      0119      0049
  20      0118      0055  0056
  30      0074      0064
  40      0072      0065
  50      0096      0083
  60      0091      0082
 100      0117      0099
 101      0105      0102
 102      0116      0106
 103      0114      0107
 601      0018      0042
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
610    0015    0050
620    0020    0058
630    0021    0063
631    0022    0069
632    0023    0061
640    0024    0073   0096
650    0025    0079
651    0026    0075
652    0027    0077
670    0028    0097
671    0029    0098
700    0030    0101
701    0031    0115
827    0032    0053

                                  /      TAG /      SIZE OF PROGRAM 001236 HEXADECIMAL BYTES PAGE 005

   NAME    TAG     TYPE  ADD.         NAME    TAG    TYPE  ADD.         NAME    TAG    TYPE  ADD.        NAME    TAG    TYPE  ADD.
     CC  F         I*4   000364         CC        C  R*4    N.R.          IO  SF       I*4   000364         IS  SFA      I*4   000368
     JS  SFA       I*4   00036C         KK  SF       I*4   000370         PI  F     C  R*4   000000         LS        C  R*4    N.R.
     VS         C  R*4    N.R.          *S  F     C  R*4   000838         XN  SF       R*4   000374        ALB        C  R*4    N.R.
    IFL  F         I*4   000378        IND           I*4   00037C        NSC  SFA      I*4   000380        TAB           R*4   000384
    TPI         C  R*4    N.R.         VAV  SF       R*4   0003C4        VSE  SFA      R*4   000300        XMC  F        R*4   000388
    XMX  F         R*4   00038C        XNN  SF       R*4   000390       FACT  SF       R*4   000394       IALB  SF       I*4   000398
   NALG  SFA       I*4   00039C       NALB  F     C  I*4   000000       NSCL  F     C  I*4   000000       SCLC  F     C  R*4   000000
   VAVJ  SF        R*4   0003DC       VCOR  SF       R*4   000418       VSET  SFA      R*4   00079C       VSIG  SFA      R*4   0007D8
   WSUN         C  R*4    N.R.        ALBO        C  R*4    N.R.       ALEPT  SFA      R*4   0003A0      CNTRX        C  R*4    N.R.
  CNTRY         C  R*4    N.R.       EDGEX        C  R*4    N.R.       EDGEY        C  R*4    N.R.      FITIT  F        R*4   0007E4
  IREGO         C  I*4   000004      IRPAT        C  I*4    N.R.      NALBL  SF       I*4   0003A4      VSIGD  SF       R*4   0003A8
  VSIGJ  SFA       R*4   0007F4      XNORM  SF       R*4   0003AC       SQRT     XF   R*4   000000     ALBECC  SF    XF R*4   000000
 IRCCH#  F    XF   I*4   000000     IRSPOT        C  I*4   000008     VSAMP2  F  XR   R*4   000000     VSAMP3  F     XR R*4   000000
 VSAMP4  F      C  R*4   000000     VSAMP5  F     C  R*4   001C20     XNORM2  SF       R*4   000380

                                    *****  COMMON INFORMATION  *****

        NAME OF COMMON BLOCK  *  FMAP*    SIZE OF BLOCK     000150 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.
           IRPAT  I*4     N.R.             IREGO  I*4   000004            IRSPOT  I*4   000008              XBND  R*4     N.R.
           CNTRX  R*4     N.R.             CNTRY  R*4     N.R.             EDGEX  R*4     N.R.             EDGEY  R*4     N.R.

        NAME OF COMMON BLOCK  *  CTAB*    SIZE OF BLOCK     001EC0 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.
          VSAMP4  R*4   000000            VSAMP5  R*4   001C20

        NAME OF COMMON BLOCK  *  GND*     SIZE OF BLOCK     000004 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.
            NALB  I*4   000000               ALB  R*4     N.R.                CG  R*4     N.R.

        NAME OF COMMON BLOCK  *  SOL*     SIZE OF BLOCK     000674 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.
            NSCL  I*4   000000              WSUN  R*4     N.R.                LS  R*4     N.R.                VS  R*4     N.R.
              WS  R*4   000E38

        NAME OF COMMON BLOCK  * CONST*    SIZE OF BLOCK     000008 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.
              PI  R*4   000000               TPI  R*4     N.R.

        NAME OF COMMON BLOCK  * SNORM*    SIZE OF BLOCK     000004 HEXADECIMAL BYTES

       VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.     VAR. NAME  TYPE  REL. ADDR.
            SCLC  R*4   000000

   LABEL   ADDR                 LABEL   ADDR                 LABEL   ADDR                 LABEL   ADDR              PAGE-006

     40   00005E                  30   000098                  60   000E22                  50   000EA4
    101   000FEE                 103   001034                 102   00111CA                100   00112A
     20   00112A                  10   00114E                   1   001172
```

190

ORIGINAL PAGE IS
OF POOR QUALITY

C-3

```
*OPTIONS IN EFFECT*     NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*   SOURCE STATEMENTS =     121,PROGRAM SIZE =    4662
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                              149K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                  OS/360  FORTRAN H                        DATE  76.324/21.51.03

        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
ISN 0002           SUBROUTINE OUTPUT(VSAMP,IND,FACT)
ISN 0003           INTEGER XCAP(3)
ISN 0004           DIMENSION VSAMP(4,5,3,1,50)
ISN 0005           DIMENSION FLX(3)
ISN 0006           COMMON/RMAP/IRPAT,IRBGD,IRSPCT,XBND,CNTRX(20),CNTRY(20),EDGEX(20),
                  *EDGEY(20)
ISN 0007           COMMON/GND/NALB,ALB(50),CG(2)
ISN 0008           COMMON/CLPAR/NCLOUD,NCLD1,CLOUD(10,10)
ISN 0009           COMMON/SOL/NSOL,WSUN(11,15,3),US(15),VS(15),WS(15)
ISN 0010           COMMON/CONST/PI,TPI
ISN 0011           COMMON/FCVR/IRCLD,IREC,RECANG,CREC,FR,C2C,IFC1,IFC2,IFC3,
                  *CINF(6),UNR,VNR,WNR,FACTR,FCINTF,CHT
                  *,INFLUX,S2C
ISN 0012           COMMON/INOUT/IIREC(2)
ISN 0013           COMMON/SNORM/SOLC
ISN 0014           COMMON/APIT/NUNIF,AUNIF(50),FTOT(50),AEFF(50)
ISN 0015           COMMON/NTFCOM/FNU(20),NFREQ,INTF
ISN 0016           DATA XCAP/1HX,1HY,1HZ/
             C
             C     INTENSITY STUDY
             C
ISN 0017           XNORM=SOLC/PI
ISN 0018           XNORM=XNORM*FACT
ISN 0019           DO 10 KK=1,2
ISN 0020           IF(KK.EQ.2)GO TO 10
ISN 0022           IF(IND.NE.1.AND.KK.EQ.2)GO TO 10
ISN 0024           IOUV=1
ISN 0025           IF(IRCLD.EQ.0)GO TO 30
ISN 0027           IFACE=IABS(IREC)
ISN 0028           IFC1=(IFACE+1)/2
ISN 0029           IFACE=IFACE/2
ISN 0030           FACTR=+1.
ISN 0031           IF(IFC1.EQ.IFACE)FACTR=-1.
ISN 0033           XFACE=FACTR*CLOUD(IRCLD,IFC1+3)
ISN 0034           IF(IIREC(KK).GT.0)WRITE(6,806)XCAP(IFC1),XFACE,IRCLD
ISN 0036           IF(IIREC(KK).LT.0)WRITE(6,807)XCAP(IFC1),XFACE,IRCLD
ISN 0038        30 CONTINUE
ISN 0039           WRITE(6,800)
ISN 0040           IF(INFLUX.EQ.1)WRITE(6,809)
ISN 0042           IF(INFLUX.EQ.0)WRITE(6,808)
ISN 0044           WRITE(6,801)SOLC
ISN 0045           IF(INFLUX.EQ.0)WRITE(6,802)
ISN 0047           IF(INFLUX.EQ.1)WRITE(6,799)
ISN 0049           IF(IRCLD.GT.0)WRITE(6,804)
ISN 0051           IF(IRCLD.LT.0)WRITE(6,803)
ISN 0053           IF(INFLUX.EQ.1)WRITE(6,809)
ISN 0055           IF(INFLUX.EQ.0)WRITE(6,808)
ISN 0057           DO 1 ISUN=1,NSOL
ISN 0058           XN2=1.
             C
             C         COX-MCKEE NORMALIZATION
             C
ISN 0059           IF(IRCLD.EQ.0)GO TO 20
ISN 0061           XN2=0.
ISN 0062           DO 21 IJ=1,3
ISN 0063           IJ2=MOD(IJ,3)+1
ISN 0064           IJ3=MOD(IJ+1,3)+1
ISN 0065           XN2=XN2+ABS(VSUN(IRCLD,ISUN,IJ)*CLOUD(IRCLD,IJ2+3)*CLOUD(IRCLD,
                  *IJ3+3)*4.)
ISN 0066        21 CONTINUE
ISN 0067           XN2=1./XN2
ISN 0068        20 CONTINUE
ISN 0069           NALBL=NALB
ISN 0070           IF((IRBGD.EQ.1).AND.(IRSPCT.EQ.1))NALBL=1
ISN 0072           IF(NALBL.EQ.1)GO TO 22
ISN 0074           IF(ISUN.EQ.1)GO TO 22
```

```
ISN 0078          IF(INFLUX.EQ.1)WRITE(6,799)
ISN 0080          IF(IRCLD.GT.0)WRITE(6,804)
ISN 0082          IF(IRCLD.LT.0)WRITE(6,805)
ISN 0084          IF(INFLUX.EQ.1)WRITE(6,809)
ISN 0086          IF(INFLUX.EQ.0)WRITE(6,808)
ISN 0088       22 CONTINUE
ISN 0089          SANG=ARCOS(WS(ISUN))*180./PI
ISN 0090          WRITE(6,810)ISUN,SANG
ISN 0091          DO 3 IALB=1,NALBL
ISN 0092          TOTF=0.
ISN 0093          DO 2 IFL=1,3
```



```
ISN 0094          FLX(IFL)=VSAMF(IOUV,ISUN,IFL,KK,IALB)*XNORM
ISN 0095          FLX(IFL)=FLX(IFL)*XN2
ISN 0096          TOTF=TOTF+FLX(IFL)
ISN 0097        2 CONTINUE
ISN 0098          MALB=-IALB
ISN 0099          CALL ALBEDO(MALB,ALBPT)
ISN 0100          WRITE(6,805)FLX(1),FLX(2),FLX(3),TOTF
ISN 0101          FTOT(IALB)=TOTF
ISN 0102        3 CONTINUE
ISN 0103          IF(NALBL.EQ.1)WRITE(6,827)NALB
ISN 0105          IF(NALBL.EQ.1)GO TO 50
            C          ALBEDO REGRESSION ANALYSIS
ISN 0107          CALL AREG(NALB,AL,BL)
ISN 0108          WRITE(6,820)AL,BL
ISN 0109          DO 40 IALB=1,NALB
ISN 0110          MALB=-IALB
ISN 0111          CALL ALBEDO(MALB,ALBPT)
ISN 0112          WRITE(6,821)AEFF(IALB)
ISN 0113       40 CONTINUE
            C          CALCULATE ALBEDO AND FLUX MTF'S
ISN 0114          IF(IMTF.NE.1)GO TO 50
ISN 0116          WRITE(6,825)
ISN 0117          DO 51 J=1,NFREQ
ISN 0118          J2=2*J
ISN 0119          J1=J2-1
ISN 0120          FMTF=(FTOT(J1)-FTOT(J2))/(FTOT(J1)+FTOT(J2))
ISN 0121          AMTF=(AEFF(J1)-AEFF(J2))/(AEFF(J1)+AEFF(J2))
ISN 0122          FMTF=FMTF*100.
ISN 0123          AMTF=AMTF*100.
ISN 0124          WRITE(6,826)J,FNU(J),FMTF,AMTF
ISN 0125       51 CONTINUE
ISN 0126       50 CONTINUE
ISN 0127        1 CONTINUE
ISN 0128       10 CONTINUE
ISN 0129          RETURN
ISN 0130      799 FORMAT(1H0,6X,'SOLAR',40X,'DIRECT',8X,'SINGLE',6X,'MULTIPLE',8X,
                 .'TOTAL'/
                 .1H ,'SUN',3X,'ZENITH',39X,'SOLAR',9X,'SCAT.',7X,'SCAT.'/
                 .1H ,'NO.',3X,'ANGLE',40X,14X,'FRACTION',4X,'FRACTION')
ISN 0131      800 FORMAT(1H0,120(1H*)/1H0,15H  FINITE CLOUDS ,10X,5HSTUDY)
ISN 0132      801 FORMAT(1H0,17HSOLAR CONSTANT = ,F8.3)
ISN 0133      802 FORMAT(1H0,6X,'SOLAR',40X,'DIRECT',8X,'UP',10X,'DOWN',12X,'TOTAL'/
                 .1H ,'SUN',3X,'ZENITH',39X,'SOLAR',9X,'GOING',7X,'GOING'/
                 .1H ,'NO.',3X,'ANGLE',40X,14X,'FRACTION',4X,'FRACTION')
ISN 0134      803 FORMAT(1H+,53X,'IN')
ISN 0135      804 FORMAT(1H+,53X,'OUT')
ISN 0136      805 FORMAT(1H+,48X,4(2X,E12.6))
ISN 0137      806 FORMAT(1H0,'**** RESULTS FOR RECEIVER POINTING INTO ',A1,'=',F8.3,
                 .' FACE OF CLOUD ',I2,' ****')
ISN 0138      807 FORMAT(1H0,'**** RESULTS FOR RECEIVER POINTING OUT OF ',A1,'=',
                 .F8.3,' FACE OF CLOUD ',I2,' ****')
ISN 0139      808 FORMAT(1H+,48X,'FLUX')
ISN 0140      809 FORMAT(1H+,48X,'INTENSITY')
ISN 0141      810 FORMAT(1H ,I2,2X,F8.3)
ISN 0142      820 FORMAT(1H0,'ALBEDO REGRESSION ANALYSIS'/
                 .1H0,'REGRESSION FORM -- (I(A)-I(0))/A = (',G14.7,')+(',G14.7,
                 .')*(I(A)-I(0))'/
                 .1H0,'ALBEDO PATTERN',34X,'FITTED ALBEDO'//)
ISN 0143      821 FORMAT(1H+,48X,F11.8)
ISN 0144      825 FORMAT(1H0,'-- MODULATION TRANSFER FUNCTION STUDY'/
                 .1H ,30X,'( PERCENT CONTRAST)'/
                 .1H0,5X,'FREQUENCY',5X,'INTENSITY MTF',5X,'ALBEDO MTF'/
                 .1H ,'NO.',2X,'(CYCLES/KM.)',3X,'(%)',15X,'(%)')
ISN 0145      826 FORMAT(1H ,I2,2X,G12.5,2X,G14.7,4X,G14.7)
ISN 0146      827 FORMAT(1H0,'RESULTS FOR ALL ',I2,' ALBEDO PATTERNS ARE SIMILAR')
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
SYMBOL   INTERNAL STATEMENT NUMBERS
J        0117  0118  0124  0124
AL       0107  0108
BL       0107  0108
CG       0007
FR       0011
IJ       0062  0063  0064  0065
J1       0119  0120  0120  0121  0121
J2       0118  0119  0120  0120  0121  0121
KK       0019  0020  0022  0034  0036  0094
PI       0010  0017  0085
US       0005
VS       0005
WS       0005  0089
ABS      0065
ALB      0007
CHT      0011
C20      0011
FLX      0005  0094  0095  0095  0096  0100  0100  0100
FNU      0015  0124
IFL      0053  0094  0094  0095  0095  0096
IJ2      0063  0065
IJ3      0064  0065
IND      0062  0062
MOD      0063  0064
SZ0      0011
TPI      0010
UNR      0011
VNR      0011
WNR      0011
XN2      0058  0061  0065  0065  0067  0067  0095
AEFF     0014  0112  0121  0121  0121  0121
AMTF     0121  0123  0123  0124
AREG     0107
CINR     0011
CREC     0011
FACT     0002  0018
FRTF     0120  0122  0122  0124
FTUT     0014  0101  0120  0120  0120  0120
IABJ     0027
IALJ     0051  0094  0098  0101  0109  0110  0112
IFC1     0011  0028  0031  0033  0034  0036
IFC2     0011
IFC3     0011
IMTF     0019  0114
IOUV     0034  0094
IREC     0011  0027
ISUN     0057  0065  0074  0089  0090  0094
MALB     0058  0059  0110  0111
NALJ     0067  0069  0103  0107  0109
NSOL     0005  0057
SANJ     0089  0090
SOLC     0013  0017  0044
TUTF     0092  0096  0096  0100  0101
WSUN     0005  0065
XJND     0076
XCAP     0003  0016  0034  0036
ALBPT    0055  0111
ARCOS    0095
AUNIF    0014
CLOUD    0006  0033  0065  0065
CNTRX    0006
CNTRY    0006
EDGEX    0006
EDGEY    0006
FACTR    0011  0030  0031  0033
IFACC    0027  0028  0029  0029  0031
IIREC    0012  0034  0036
IREJD    0006  0070
IRCLD    0011  0025  0033  0034  0036  0049  0051  0059  0065  0065  0065  0080  0082
IRPAT    0006
NALBL    0069  0070  0072  0091  0103  0105
NCLD1    0028
NFREQ    0015  0117
NUNIF    0014
VSAMP    0002  0004  0094
```

```
XFACE    0033  0024  0036
XNCRM    0017  0018  0018  0094
ALBEDO   0059  0111
INFLUX   0011  0040  0042  0045  0047  0053  0055  0076  0078  0084  0086
```

PAGE 004

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

SYMBOL   INTERNAL STATEMENT NUMBERS
IRSPUT   0006  0070
NCLOUD   0008
OUTPUT   0002
POINTR   0011
RECANG   0011
```

PAGE 005

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

LABEL   DEFINED   REFERENCES
  1     0127      0057
  2     0057      0053
  3     0102      0091
 10     0128      0019  0020  0022
 20     0068      0059
 21     0066      0062
 22     0068      0072  0074
 30     0038      0025
 40     0113      0109
 50     0126      0105  0114
 51     0125      0117
799     0130      0047  0078
800     0131      0039
801     0132      0044
802     0133      0045  0076
803     0134      0051  0082
804     0135      0049  0080
805     0136      0101
806     0137      0034
807     0138      0036
808     0139      0042  0055  0086
809     0140      0040  0053  0084
810     0141      0090
820     0142      0106
821     0143      0112
825     0144      0116
826     0145      0124
827     0146      0103
```

```
/ OUTPUT /     SIZE OF PROGRAM 000E0C HEXADECIMAL BYTES PAGE 006

 NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.
    J SF      I*4  0004A0        AL SFA    R*4  0004A4        LL SFA    R*4  0004A8        CG      C R*4    N.R.
   FR      C  R*4    N.R.        IJ SFA    I*4  0004AC        J1 SF     I*4  0004B0        J2 SF     I*4  000484
   KK SF      I*4  0004E8        PI  F   C R*4  000000        US      C R*4    N.R.        VS      C R*4    N.R.
   WS  FA  C  R*4  000E38       ALB      C R*4    N.R.       CFT      C R*4    N.R.       CZC      C R*4    N.R.
  FLX SF      R*4  0005CC       FNU  F   C R*4  000000       IFL SF     I*4  0004BC       IJ2 SFA   I*4  0004C0
  IJ3 SFA     I*4  0004C4       IND        I*4  0004C8       SZO      C R*4    N.R.       TPI      C R*4    N.R.
  UNR      C  R*4    N.R.       VNR      C R*4    N.R.       WNR      C R*4    N.R.       XN2 SF    R*4  0004CC
 AEFF  F   C  R*4  000194      AMIF SF     R*4  0004D0      AREG SF  XF R*4  000000      CINR      C R*4    N.R.
 CREC      C  R*4    N.R.      FACI  F     R*4  0004D4      FMTF SF     R*4  0004D8      FTCT SF   C R*4  0000CC
 IALB SF      I*4  0004DC      IFC1 SF   C I*4  000018      IFC2      C I*4    N.R.      IFC3      C I*4    N.R.
 INTF      C  I*4  000054      IOUV SF     I*4  0004E0      IREC  FA  C I*4  000004      ISUN SFA   I*4  0004E4
 NALB SFA     I*4  0004E8      NALB SFA  C I*4  000000      NSUL  F   C I*4  000000      SANG SF    R*4  0004EC
 SCLC  F   C  R*4  000000      TOTF SF     R*4  0004F0      WSUN  FA  C R*4  000004      XBND      C R*4    N.R.
 XCAP  F      I*4  000518     ALBPT SFA    R*4  0004F4     AUNIF      C R*4    N.R.     CLCLD  FA  C R*4  000008
CNTRX      C  R*4    N.R.     CNTRY      C R*4    N.R.     EDGEX      C R*4    N.R.     EDGEY      C R*4    N.R.
FACTR SF   C  R*4  000048     IFACE SF     I*4  0004F8     IIREC      C I*4  000000     IRBGD      C I*4  000004
IRCLD  FA  C  I*4  000000     IRPAT      C I*4    N.R.     NALBL SF     I*4  0004FC     NCLD1      C I*4    N.R.
NFREG  F   C  I*4  00005C     NUNIF      C I*4    N.R.     VSAMP  F  XF R*4  000000     XFACE SF     R*4  000500
XNCRM SF      R*4  000504     ARCOS   XF   R*4  000000    ALBEDO SF  XF R*4  000000    IBCCM#  F  XF I*4  000000
INFLUX     C  I*4  000054    IRSPUT      C I*4  000008    NCLOUD      C I*4    N.R.    OUTPUT       R*4  000508
POINTR     C  R*4    N.R.    RECANG      C R*4    N.R.

*****   COMMON INFORMATION   *****
```

ORIGINAL PAGE IS OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

```
NAME OF COMMON BLOCK  *  RMAP*   SIZE OF BLOCK    000150 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  IRPAT    I*4     N.R.         IRGGU    I*4    000004        IRSPLT   I*4    000008         XBND    R*4     N.R.
  CNTRX    R*4     N.R.         CNTRY    R*4     N.R.         EDGEX    R*4     N.R.          EDGEY   R*4     N.R.

NAME OF COMMON BLOCK  *  GND*    SIZE OF BLOCK    000004 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  NALB     I*4    000000         ALB     R*4     N.R.           CG     R*4     N.R.

NAME OF COMMON BLOCK  * CLPAR*   SIZE OF BLOCK    000198 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  NCLCUD   I*4     N.R.         NCLC1    I*4     N.R.         CLCUD    R*4    000008

NAME OF COMMON BLOCK  *  SOL*    SIZE OF BLOCK    000874 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  NSCL     I*4    000000         *SUN    R*4    000004          US     R*4     N.R.            VS    R*4     N.R.
   *S      R*4    000E38

NAME OF COMMON BLOCK  * CCNST*   SIZE OF BLOCK    000008 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
   PI      R*4    000000         TPI     R*4     N.R.

NAME OF COMMON BLOCK  *  RCVR*   SIZE OF BLOCK    00005C HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  IRCLD    I*4    000000         IREC    I*4    000004        RECANG   R*4     N.R.          CREC    R*4     N.R.
   FR      R*4     N.R.          C20     R*4     N.R.          IFC1    I*4    000018          IFC2    I*4     N.R.
  IFC3     I*4     N.R.          CINR    R*4     N.R.          UNR     R*4     N.R.           VNR    R*4     N.R.
  WNR      R*4     N.R.         FACTR    R*4    000046        FCINTR   R*4     N.R.           CHT    R*4     N.R.
  INFLUX   I*4    000054         S20     R*4     N.R.

NAME OF COMMON BLOCK  * INCUT*   SIZE OF BLOCK    000008 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  IIREC    I*4    000000

NAME OF COMMON BLOCK  * SNCRA*   SIZE OF BLOCK    000004 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  SCLC     R*4    000000
```

PAGE 007

```
NAME OF COMMON BLOCK  *  AFIT*   SIZE OF BLOCK    00025C HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  NUNIF    I*4     N.R.         AUNIF    R*4     N.R.          FTLT    R*4    0000CC          AEFF    R*4    000194

NAME OF COMMON BLOCK  *NTFCOM*   SIZE OF BLOCK    000058 HEXADECIMAL BYTES

VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  FNU      R*4    000000        NFRLG    I*4    000050         IMTF    I*4    000054
```

```
LABEL   ADDR          LABEL   ADDR          LABEL   ADDR          LABEL   ADDR
 30    000728          21    00090A          20    000926          22    000A40
  2    00031E           3    000B80          40    000C5C          51    000D2C
 50    00004E           1    000052          10    000D7A
```

PAGE 008

```
*OPTIONS IN EFFECT*     NAME= MAIN,OPT=02,LINECNT=82,SIZE=0000K,

*OPTIONS IN EFFECT*     SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

*STATISTICS*    SOURCE STATEMENTS =     140 ,PROGRAM SIZE =      3596
```

```
*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                   153K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                        OS/360  FORTRAN H                         DATE  76.324/21.51.14

          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=62,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
   ISN 0002          SUBROUTINE ALBEDO(IALB,ALBPT)
   ISN 0003          COMMON/GND/NALB,ALB(50),CG(2)
   ISN 0004          COMMON/AFIT/NUNIF,AUNIF(50),FTCT(50),AEFF(50)
   ISN 0005          COMMON/MTFCOM/FNU(20),NFREQ,INTF
               C
               C     S U B R O U T I N E   A L B E D O
               C
               C     THIS SUBROUTINE SERVES TWO FUNCTIONS
               C      A) IF IALB .GT. 0  ALBEDO COMPUTES AND RETURNSTHE VALUE OF THE
               C            GROUND ALBEDO AT THE POINT X=CG(1), Y=CG(2) FOR THE ALBEDO
               C            PATTERN SPECIFIED BY IALB.
               C      B) IF IALB .LT. 0  ALBEDO PRINTS A DESCRIPTION OF THE ALBEDO
               C            PATTERN SPECIFIED BY IABS(IALB)
               C
               C     VERSION FOR
               C     SINUSOIDAL ALBEDO PATTERNS FOR MTF DERIVATION
               C
   ISN 0006          DIMENSION FREQ(20),AUN(10)
   ISN 0007          DATA FREQ/.01,.02,.04,.08,.1,.2,.4,.6,.8,1.,2.,4.,6.,8.,10.,12.,
                    *14.,16.,18.,20./
                    *,AUN/1.,.7,.6,.5,.4,.2,.155,.150,.1,0./
   ISN 0008          NUNIF=10
   ISN 0009          INTF=1
   ISN 0010          NFREQ=20
   ISN 0011          IF(AUNIF(1).EQ.AUN(1))GO TO 201
   ISN 0013          DO 200 I=1,NUNIF
   ISN 0014      200 AUNIF(I)=AUN(I)
   ISN 0015          NA=(NALB-NUNIF)/2
   ISN 0016          DO 202 I=1,NA
   ISN 0017      202 FNU(I)=FREQ(I)
   ISN 0018      201 CONTINUE
   ISN 0019          PI=3.141593
   ISN 0020          TPI=2.*PI
   ISN 0021          B0=.5
   ISN 0022          B1=.5
   ISN 0023          MALB=IABS(IALB)
   ISN 0024          IF(MALB.GT.40)GO TO 102
               C         SINUSOIDS
   ISN 0026          IMAL=(MALB-1)/2+1
   ISN 0027          IBND=MOD(MALB-1,2)
   ISN 0028          F=FLOAT(IBND)
   ISN 0029          ALBPT=0.
   ISN 0030          IF(IALB.GE.0)ALBPT=B0+B1*COS(TPI*CG(1)*FREQ(IMAL)+F*PI)
   ISN 0032          IF(IALB.LT.0)WRITE(6,111)MALB,B0,B1,FREQ(IMAL),F
   ISN 0034          RETURN
               C         UNIFORM PLANE
   ISN 0035      102 CONTINUE
   ISN 0036          IMAL=MALB-40
   ISN 0037          XALB=AUN(IMAL)
   ISN 0038          IF(IALB.LE.0)WRITE(6,120)MALB,XALB
   ISN 0040          IF(IALB.GT.0)ALBPT=XALB
   ISN 0042          RETURN
   ISN 0043      120 FORMAT(1H ,I2,'-- UNIFORM PLANE, A= ',F7.4,' EVERYWHERE')
   ISN 0044      111 FORMAT(1H ,I2,'-- SINUSOIDAL PATTERN'/
                    *1H ,3X,'A=(',F6.3,')+(',F6.3,')*COS(2.*PI*NU*X+F*PI)'/
                    *1H ,5X,'NU = ',G14.7,'CYCLES/KM., F= ',F3.0)
   ISN 0045          END

                 *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 002

SYMBOL    INTERNAL STATEMENT NUMBERS
F         0028  0030  0032
I         0013  0014  0014  0016  0017  0017
B0        0021  0030  0032
B1        0022  0030  0032
CG        0003  0030
NA        0015  0016
PI        0019  0020  0030
ALB       0003
AUN       0006  0007  0011  0014  0037
COS       0030
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
FNU       0005   0017
MOD       0027
TPI       0020   0030
AEFF      0004
FREQ      0006   0007   0017   0033   0032
FTOT      0004
IABS      0023
IALE      0032   0023   0030   0032   0038   0045
IBND      0027   0028
IMAL      0020   0030   0032   0036   0037
IMTF      0005   0009
MALB      0023   0024   0026   0027   0032   0036   0038
NALB      0003   0015
XALB      0037   0038   0040
ALBPT     0022   0029   0030   0040
AUNIF     0004   0011   0014
FLOAT     0028
NFREQ     0005   0010
NUNIF     0004   0008   0013   0015
ALBEDO    0002
```

```
*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****          PAGE 003

  LABEL   DEFINED   REFERENCES
   102     0035      0024
   111     0044      0032
   120     0043      0038
   200     0014      0013
   201     0018      0011
   202     0017      0016
```

```
                    /  ALBEDO /    SIZE OF PROGRAM 000482 HEXADECIMAL BYTES PAGE 004

   NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.
      F  SFA    R*4  00014C        I  SF     I*4  000150       E0  SF     R*4  000154       E1  SF     R*4  000158
     CG  FA  C  R*4  0000CC       NA  SF     I*4  00015C       FI  SFA    R*4  000160      ALB      C  R*4    N.R.
    ALN  F      R*4  000184      FNU  S   C  R*4  000000      TPI  SFA    R*4  000164     AEFF      C  R*4    N.R.
   FREQ  FA     R*4  0001AC     FTOT  S   C  R*4    N.R.     IALB  FA     I*4  000168     IBND  SFA    I*4  00016C
   IMAL  SFA    I*4  000170     IMTF  S   C  I*4  000054     MALB  SFA    I*4  000174     NALB  F   C  I*4  000000
   XALB  SF     R*4  000178    ALBPT  S      R*4  00017C    AUNIF  S   C  R*4  000004    NFREQ  S   C  I*4  000050
  NUNIF  SF  C  I*4  000000      COS     XF  R*4  000000   ALBEDO         R*4  000180    IBCOM#  F  XF  I*4  000000

                              *****  COMMON INFORMATION  *****

   NAME OF COMMON BLOCK  *  GND*   SIZE OF BLOCK   000004 HEXADECIMAL BYTES

 VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
    NALB     I*4   000000          ALB     R*4    N.R.            CG     R*4   0000CC

   NAME OF COMMON BLOCK  *  AFIT*   SIZE OF BLOCK   00025C HEXADECIMAL BYTES

 VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
    NUNIF    I*4   000000        AUNIF     R*4   000004         FTOT     R*4    N.R.          AEFF     R*4    N.R.

   NAME OF COMMON BLOCK  *MTFCOM*   SIZE OF BLOCK   000058 HEXADECIMAL BYTES

 VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
      FNU    R*4   000000        NFREQ     I*4   000050         IMTF     I*4   000054
```

```
  LABEL   ADDR              LABEL   ADDR              LABEL   ADDR              LABEL   ADDR          PAGE 005
   200   000232              202   0002EC              201   0002C8              102   0002E2

*OPTIONS IN EFFECT*    NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
*OPTIONS IN EFFECT*    SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*     SOURCE STATEMENTS =     44 ,PROGRAM SIZE =     1154
*STATISTICS*  NO DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                          173K BYTES OF CORE NOT USED
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
COMPILER OPTIONS - NAME= MAIN,OPT=02,LINECNT=62,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
ISN 0002          SUBROUTINE AREG(NALB,AL,BL)
ISN 0003          DIMENSION Y(50),X(50)
ISN 0004          COMMON/AFIT/NUNIF,AUNIF(50),FTOT(50),AEFF(50)
ISN 0005          IF(NALB.LE.1)RETURN
ISN 0007          IHI=NUNIF-1
ISN 0008          ID=NALB-NUNIF
ISN 0009          DO 1 I=1,IHI
ISN 0010          IP=I+ID
ISN 0011          YY=FTOT(IP)-FTOT(NALB)
ISN 0012          Y(I)=YY/AUNIF(I)
ISN 0013          X(I)=YY
ISN 0014        1 CONTINUE
ISN 0015          CALL LINFIT(IHI,Y,X,AL,BL)
ISN 0016          IDD=NALB-1
ISN 0017          DO 2 J=1,IDD
ISN 0018          FI=FTOT(J)-FTOT(NALB)
ISN 0019          AEFF(J)=FI/(AL+BL*FI)
ISN 0020        2 CONTINUE
ISN 0021          AEFF(NALB)=0.
ISN 0022          RETURN
ISN 0023          END
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G***** PAGE 002

```
SYMBOL   INTERNAL STATEMENT NUMBERS
I        0009  0010  0012  0012  0013
J        0017  0018  0019
X        0003  0013  0015
Y        0003  0012  0015
AL       0002  0015  0019
BL       0002  0015  0019
FI       0018  0019  0019
ID       0008  0010
IP       0010  0011
YY       0011  0012  0013
IDD      0016  0017
IHI      0007  0009  0015
AEFF     0004  0019  0021
AREG     0002
FTOT     0004  0011  0011  0018  0018
NALB     0002  0005  0008  0011  0016  0018  0021
AUNIF    0004  0012
NUNIF    0004  0007  0008
LINFIT   0015
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G***** PAGE 003

```
LABEL   DEFINED   REFERENCES
  1     0014      0009
  2     0020      0017
```

/ AREG / SIZE OF PROGRAM 000396 HEXADECIMAL BYTES PAGE 004

```
NAME   TAG   TYPE  ADD.      NAME   TAG   TYPE  ADD.      NAME    TAG   TYPE  ADD.      NAME  TAG   TYPE  ADD.
   I SF      I*4   000090       J SF      I*4   000094       X SFA      R*4   0000C0       Y SFA    R*4   000188
  AL SFA     R*4   000098      BL SFA     R*4   00009C      FI SF       R*4   0000A0      ID SF     I*4   0000A4
  IP SF      I*4   0000A8      YY SF      R*4   0000AC     IDD SF       I*4   0000B0     IHI SFA    I*4   0000B4
AEFF S    C  R*4   000194    AREG         R*4   0000B8    FTOT F    C   R*4   0000CC    NALB F      I*4   0000BC
AUNIF F   C  R*4   000004   NUNIF F    C  I*4   000000  LINFIT SF   XF  I*4   000000
```

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * AFIT* SIZE OF BLOCK 00025C HEXADECIMAL BYTES

```
VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.   VAR. NAME  TYPE  REL. ADDR.
  NUNIF    I*4   000000         AUNIF    R*4   000004         FTOT     R*4   0000CC         AEFF     R*4   000194
```

```
LABEL  ADDR          LABEL  ADDR          LABEL  ADDR          LABEL  ADDR          PAGE 005
```

```
1  0002DC              2  000328

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
*OPTIONS IN EFFECT*      SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*    SOURCE STATEMENTS =      22 ,PROGRAM SIZE =      918
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******                                   181K BYTES OF CORE NOT USED

LEVEL  21.6  (DEC 72)                    OS/360  FORTRAN H                       DATE  76.324/21.51.28
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
   ISN 0002                 SUBROUTINE LINFIT(N,Y,X,A,B)
                     C
                     C            FITS LINE Y=A+B*X FROM VECTORS Y(N),X(N)
                     C
   ISN 0003                 DIMENSION X(1),Y(1)
   ISN 0004                 A=0.
   ISN 0005                 B=0.
   ISN 0006                 IF(N.LE.1)RETURN
   ISN 0008                 SXY=0.
   ISN 0009                 SX=0.
   ISN 0010                 SY=0.
   ISN 0011                 SX2=0.
   ISN 0012                 DO 1  J=1,N
   ISN 0013                 SXY=SXY+X(J)*Y(J)
   ISN 0014                 SX=SX+X(J)
   ISN 0015                 SY=SY+Y(J)
   ISN 0016                 SX2=SX2+X(J)*X(J)
   ISN 0017               1 CONTINUE
   ISN 0018                 XN=FLOAT(N)
   ISN 0019                 B=(XN*SXY-SX*SY)/(XN*SX2-SX*SX)
   ISN 0020                 A=(SY-B*SX)/XN
   ISN 0021                 RETURN
   ISN 0022                 END

                   *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****     PAGE 002
SYMBOL  INTERNAL STATEMENT NUMBERS
A        0002  0004  0020
B        0002  0005  0019  0020
J        0012  0013  0013  0014  0015  0016  0016
N        0002  0006  0012  0018
X        0002  0003  0013  0014  0016  0016
Y        0002  0003  0013  0015
SX       0009  0014  0014  0019  0019  0019  0020
SY       0010  0015  0015  0019  0020
XN       0018  0019  0019  0020
SXY      0008  0013  0013  0019
SX2      0011  0016  0016  0019
FLOAT    0018
LINFIT   0002

                   *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****     PAGE 003
  LABEL   DEFINED   REFERENCES
    1     0017      0012

                               /  LINFIT /    SIZE OF PROGRAM 000248 HEXADECIMAL BYTES PAGE 004

     NAME   TAG    TYPE  ADD.        NAME   TAG    TYPE  ADD.      NAME   TAG    TYPE  ADD.      NAME   TAG    TYPE  ADD.
        A  S       R*4   000090         B  SF      R*4   000094       J  SF      I*4   000098       N  FA      I*4   00009C
        X  F  XR   R*4   000000         Y  F  XR   R*4   000000      SX  SF      R*4   0000A0      SY  SF      R*4   0000A4
       XN  SF      R*4   0000A8       SXY  SF      R*4   0000AC     SX2  SF      R*4   0000B0  LINFIT          I*4   000084

  LABEL   ADDR          LABEL   ADDR          LABEL   ADDR          LABEL   ADDR                                   PAGE 005
     1  00014E

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=82,SIZE=0000K,
```

ORIGINAL PAGE IS OF POOR QUALITY

REFERENCES

1. Cox, C. and Munk, W., (1955), J. of Marine Res., 14, 63.

2. Coulson, K.L., Dave, J.V., and Sekera, Z., "Tables Related to Radiation Emerging From a Planetary Atmosphere with Rayleigh Scattering," (1960), University of California Press.

3. McKee, T.B. and Cox, S.K., (1974), J. of Atm. Sci., 31, 1885.

4. Plass, G.N., Kattawar, G.W., and Guinn, J.A., (1975), Appl. Opt., 14, 1924.

5. Deirmendjian, D., "Electromagnetic Scattering on Spherical Polydispersion," (1969), American Elesevier Pub. Co., New York, N.Y. (especially pp. 75-78).

WOLF RESEARCH AND DEVELOPMENT CORPORATION

6801 KENILWORTH AVENUE • P.O. BOX 398 • RIVERDALE • MARYLAND 20840 • TEL. (301) 779-2800